Scientific and Medical
Books, and Minerals.
A. E. FOOTE, M. D.,
Philadelphia, Pa.

QP
44
B95
v. 2

CORNELL UNIVERSITY.

THE

Roswell P. Flower Library

THE GIFT OF

ROSWELL P. FLOWER

FOR THE USE OF

THE N. Y. STATE VETERINARY COLLEGE.

1897

Cornell University Library
QP 44.B95
V.2
Handbook for the physiological laborator
3 1924 001 046 378
vet

2 vol 2°

Kleine

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924001046378

No. 206

HANDBOOK

FOR THE

PHYSIOLOGICAL LABORATORY.

BY

E. KLEIN, M.D.,
ASSISTANT PROFESSOR IN THE PATHOLOGICAL LABORATORY OF THE BROWN INSTITUTION, LONDON, FORMERLY PRIVAT-DOCENT IN HISTOLOGY IN THE UNIVERSITY OF VIENNA;

J. BURDON-SANDERSON, M.D., F.R.S.,
PROFESSOR OF PRACTICAL PHYSIOLOGY IN UNIVERSITY COLLEGE, LONDON;

MICHAEL FOSTER, M.A., M.D., F.R.S.,
FELLOW OF, AND PRÆLECTOR OF PHYSIOLOGY IN, TRINITY COLLEGE, CAMBRIDGE;

AND

T. LAUDER BRUNTON, M.D., D.Sc.,
LECTURER ON MATERIA MEDICA IN THE MEDICAL COLLEGE OF ST. BARTHOLOMEW'S HOSPITAL, LONDON.

EDITED BY
J. BURDON-SANDERSON.

ROSWELL P. FLOWER, LIBRARY. N.Y. STATE VET. COLL.

IN TWO VOLUMES,

WITH ONE HUNDRED AND THIRTY-THREE PLATES,

CONTAINING

THREE HUNDRED AND FIFTY-THREE ILLUSTRATIONS.

VOLUME II. PLATES.

PHILADELPHIA:
LINDSAY AND BLAKISTON.
1873.

Flowe
lib

QP
44
B95
v.2

~~[illegible]~~ II
No 206

COLLINS, PRINTER,
705 Jayne Street.

LIST OF ILLUSTRATIONS.

PLATE I.

Fig. 1. Simple Arrangement for warming an Object under the Microscope.
" 12. Similar but more complicated Apparatus.
" 2. Stricker's Warm Stage.
" 13. Rod for Heating Stage.
" 16. Object Support with Gas Chamber.

PLATE II.

Fig. 3. Mode of warming an Object under the microscope by means of Current of Hot Water.
" 4. Capillary Pipette.
" 14. Stricker's Stage for warming a Preparation by Voltaic Current.

PLATE III.

Fig. 5. Carbonic Acid Apparatus.
" 6. Microscope Stage with Stricker's Electrodes.

PLATE IV.

Fig. 17. Injecting Syringe.
" 11. Support for Study of Circulation in Web of Frog's Foot.
" 20. Injecting Canulæ.
" 21. Section Knife.
" 18. Nozzle of Injection Syringe.
" 19. Support for Studying Circulation in Mesentery.

PLATE V.

Fig. 22. Large Colorless Corpuscle of Newt.
" 23. Granular Corpuscle of Newt.
" 24. Action of different Reagents on Blood Corpuscles.

PLATE VI.

Fig. 26. Action of Heat on Colorless Corpuscles of Human Blood.
" 7. Epithelial Cells from Trachea of Cat.

PLATE VII.

Fig. 26. Epithelial Cells from Bladder of Rabbit.
" 27. " " of Rete Malpighii from Pointed Condyloma.
" 28. Superficial Cells of the same Preparation.
" 29. Jagged Epithelial Cells of Gum.

PLATE VIII.

Figs. 30 and 32. Abdominal Surface of Centrum Tendineum of Rabbit.
Fig. 31. Pleural " " " "

PLATE IX.

Fig. 33. Omentum of Guineapig treated with Silver.
" 34. Fenestrated Portion of Omentum of Ape.

PLATE X.

Fig. 35. Omentum of Ape, showing Groups of germinating Endothelial Cells.
" 37. Silver Preparation of Septum of Cisterna Lymphatica of Female Frogs.

PLATE XI.

Fig. 37. Germinating Endothelium of Pleural Mediastinum of Cat.
" 38. Mesogastrium of Frog covered with Ciliated germinating Endothelium.

PLATE XII.

Fig. 39. Cornea of Frog treated with Lunar Caustic.
" 40. Horizontal Preparation of Cornea of Frog colored with Chloride of Gold.

PLATE XIII.

Fig. 41. Horizontal Preparation of Cornea of Rabbit treated with Lunar Caustic and Salt Solution.
" 42. Membrana Nictitans of Frog treated with the Chloride of Gold.
" 43. Surface of Inflamed Mesentery of Ape.
" 44. " " " " showing Branched Cells of Canalicular System filled with Fat Globules.
" 45. Fat Cells, Omentum of Rat.

PLATE XIV.

Figs. 46 and 47. Cells of Gelatinous Substance of Infra-orbital Fossa of Rabbit.

PLATE XV.

Fig. 48. Cells of Parietal Peritoneum of Rabbit with Chronic Peritonitis.
" 49. " of Submucous Tissue of Gravid Uterus of Sow.
" 50. " of Gelatinous Substance of Infra-orbital Fossa of Rabbit being converted into Fat-cells.

PLATE XVI.

Fig. 51. Branched Cells of Omentum of Rabbit.

PLATE XVII.

Fig. 52. Cells of Caudal Tendon of young Rat; Silver Preparation.
" 53. " " " of full-grown Rat.
" 54. " " " of young Rat; Gold Preparation.
" 55. Transverse Section of Tendon from Tail of Rabbit.
" 8. Connective Tissue Trabeculæ from Omentum of Guineapig.

PLATE XVIII.

Fig. 56. Elastic Fibres from Mesentery of Rabbit.
" 57. Intervertebral Cartilage of Tail of Rabbit.

PLATE XIX.

Fig. 58. Transverse Section of Epiphysis of Femur of Human Fœtus.

PLATE XX.

Fig. 59. Longitudinal Section of Epiphysis of Femur of Human Fœtus.

PLATE XXI.

Fig. 60. Transverse Section of Diaphysis of Femur of Human Fœtus.

PLATE XXII.

Fig. 61. Vertical Section of Parietal Bone of a Child.

PLATE XXIII.

Fig. 62. Longitudinal Section of Epiphysis of Metatarsal Bone of Rabbit.

PLATE XXIV.

Fig. 15. Diagram to illustrate the Course of a Ray of Light transmitted through a Muscular Fibre.
" 63. Longitudinal section of Muscular Coat of Fallopian Tube of Sow.
" 64. Transition of Striped Muscular Fibre into Tendon in Tail of Rabbit.
" 65. Muscular Fibre of Hydrophilus Piceus.

PLATE XXV.

Fig. 66. Section of Injected Muscle.
" 67. Smooth Muscular Fibre.
" 68. Striped Muscular Fibre of Frog.

PLATE XXVI.

Fig. 69. Group of Ganglion Cells of a Sympathetic Nerve Trunk from Bladder of Rabbit.
" 70. Ganglion Cells with Spiral Fibres.

ROSWELL P. FLOWER LIBRARY. N.Y. STATE VET. COLL.

PLATE XXVII.

Fig. 71. Ganglion Cells from Spinal Cord of Calf.
" 73. Superficial Intra-epithelial Network of Non-medullated Nerve Fibres from Cornea of Rabbit.
" 74. Sub-epithelial Nerve-plexus from Cornea of Rabbit.

PLATE XXVIII.

Fig. 72. Branched Ganglion Cell from Spinal Cord of Calf.
" 75. Nerves of Substantia Propria of Cornea of Rabbit.

PLATE XXIX.

Fig. 76. Intra-epithelial Non-medullated Nerve Fibrils of Cornea of Rabbit.
" 77. Auerbach's Plexus from small Intestine of Human Fœtus.

PLATE XXX.

Fig. 78. Sub-epithelial Nerve Branchings of Cornea of Guineapig.
" 79. Non-medullated Nerve Fibres from Cornea of Rabbit.

PLATE XXXI.

Fig. 80. Superficial Intra-epithelial Network of Non-medullated Nerve Fibres, Cornea of Guineapig.
" 81. Non-medullated Nerve Fibres from Cornea of Frog.

PLATE XXXII.

Fig. 82. Nerve Fibres of Substantia Propria of Cornea of Frog.
" 83. Sub-epithelial and deep Intra-epithelial Nerve Fibrils from Cornea of Rabbit.

PLATE XXXIII.

Fig. 84. Deep Intra-epithelial Network of fine Non-medullated Nerve Fibres of Cornea of Rabbit.
" 85 Superficial Intra-epithelial Nerve Fibres of Cornea of Rabbit.
" 86. Nerve Fibres and Corpuscles of Cornea of Frog.

PLATE XXXIV.

Fig 87. Non-medullated Nerve Fibres of a Capillary Bloodvessel.
" 88. Nerve Fibres of Mesentery of Frog.

PLATE XXXV.

Fig. 89. Nerve Fibres and Capillary Bloodvessel from Tail of Tadpole.

PLATE XXXVI.

Fig. 90. Plexus of Non-medullated Nerve Fibres round Capillary Bloodvessel from Mesentery of Frog.
" 91. Non-medullated Nerve Fibres surrounding Capillary Bloodvessel from Tongue of Frog.
" 92. Plexuses of Non-medullated Nerve Fibres surrounding Bundles of Unstriped Muscle from Vagina of Rabbit.

PLATE XXXVII.

Fig. 93. Distribution of Non-medullated Nerve Fibres from Base of a Gland of Membrana Nictitans of Frog.
" 9. Non-medullated Nerve Fibres surrounding small Artery of Tongue of Frog.

PLATE XXXVIII.

Fig. 94. Sub-epithelial Non-medullated Nerve Fibres of Vagina of Rabbit.
" 95. Non-medullated Nerve Fibres in Adventitia of large Vein from Mesentery of Frog.
" 96. Non-medullated Nerve Fibres in Adventitia of large Artery from Mesentery of Frog.

PLATE XXXIX.

Fig. 97. Sub-epithelial Non-medullated Nerve Fibres of Membrana Nictitans of Frog.
" 98. Bloodvessels of Injected Mesenteric Gland of Guineapig.

PLATE XL.

Fig. 99. Longitudinal Section of Branch of Pulmonary Artery from Lung of Guineapig.
" 100. Transverse Section of Artery from Skin of Guineapig; Gold Preparation.
" 101. Omentum of Rabbit, showing Development of young Capillaries.
" 102. Capillary Bloodvessel extending into a Branched Cell.

PLATE XLI.

Fig. 103. Endothelium of a large Vein and Artery of Omentum of Rabbit; Silver Preparation.

PLATE XLII.

Fig. 104. Endothelium of Capillary Bloodvessel of Omentum of Rabbit.

PLATE XLIII.

Fig. 105. Capillary System of Mucosa from Injected Stomach of Rat.
" 106. Fat Tract from Injected Omentum of Guineapig.
" 107. Superficial Capillary Meshwork of Mucous Membrane, Injected Uterus of Guineapig.

PLATE XLIV.

Fig. 108. Superficial Arteries, dense Network of Capillaries, and deep Veins of Mucous Membrane of Stomach of Rat.
" 109. Masses of Tubercle from Injected Omentum of Guineapig.

PLATE XLV.

Fig. 110. Bloodvessels of Striped Muscle from Injected Tongue of Rabbit.

PLATE XLVI.

Fig. 111. Stomata of Mesentery of Frog.
" 112. Stomata of Septum Cisternæ Lymphaticæ Magnæ of Frog.

PLATE XLVII.

Fig. 113. Germination of Endothelium round Stomata of Mesentery of Guineapig affected with Chronic Inflammation.

PLATE XLVIII.

Fig 114. Stomata of Peritoneal Surface of Centrum Tendineum of Rabbit.
" 115. Stomata on a Lymph Vessel of Mesentery of Guineapig.

PLATE XLIX.

Fig. 116. Germination of Endothelium on Mesentery of Guineapig affected with Chronic Inflammation; Silver Preparation.

PLATE L.

Fig. 117. Lymph Capillaries of Peritoneal Serosa of Centrum Tendineum of Rabbit.
" 118. Lymph Vessels of Pleural Serosa of Centrum Tendineum of Guineapig.

PLATE LI.

Fig. 119. Pleural Surface of Centrum Tendineum of Rabbit, showing rich Network of Lymph Vessels.

PLATE LII.

Fig. 120. Lymphatics of Centrum Tendineum of Rabbit.

PLATE LIII.

Fig. 121. Lymphatics of Omentum of Rabbit; Silver Preparation.

PLATE LIV.

Fig. 122. Surface of Omentum of Rabbit, showing Distribution of Lymph Vessels; Silver Preparation.

PLATE LV.

Fig. 123. Pleural Side of Centrum Tendineum of Guineapig affected with Chronic Inflammation.

PLATE LVI.

Fig. 124. Pleural Side of Centrum Tendineum of Rabbit; Silver Preparation.

PLATE LVII.

Fig. 125. Lymph Vessels of Pleural Side of Centrum Tendineum of Rabbit.

PLATE LVIII.

Fig. 126. Artery and Lymphatic Vessel of Omentum of Rabbit; Silver Preparation.
" 127. Adenoid Tissue of Mesenteric Gland of Ox.

PLATE LIX.

Fig. 128. Natural Injection of Lymphatics of Centrum Tendineum of Rabbit.

PLATE LX.

Fig. 129. Section of Medullary Substance of Mesenteric Gland of Ox.

PLATE LXI.

Fig. 130. Alveolus from Section of Lung of Rabbit.
" 132 Section of Lung of Rabbit Injected.
" 133. Trabeculæ of Liver Cells of Guineapig.

PLATE LXII.

Fig. 134. Section of Liver of Dog Injected from Vena Portæ.
" 135. Section of Liver of Rabbit, the Portal Vein and Hepatic Duct of which are Injected.

PLATE LXIII.

Fig. 136. Section of Injected small Intestine of Rat.
" 137. " " Villus of small Intestine of Cat.
" 138. " " Filiform Papillæ of Tongue of Rabbit.
" 139. " " Large Bronchus of Human Fœtus.

PLATE LXIV.

Fig. 140. Injected Follicles of Section of Peyer's Patches from small Intestine of Rabbit.
" 141. Section of Ileum of Dog.

PLATE LXV.

Fig. 142. Section of Acinus from Liver of Rabbit.
" 143. Section of Injected Kidney of Rat.
" 144. Urinary Tubes of Pyramidal Substance of Injected Kidney of Pig.

PLATE LXVI.

Fig. 145. Transverse Section of Injected Kidney of Rat.

PLATE LXVII.

Fig 146. Transverse Section of Pyramidal Substance of Kidney of Pig.
" 147. Preparation from Kidney of Pig showing a Henle's Loop.
" 148. Similar Preparation, showing Portion of Collecting Tube in Pyramidal Process.
" 149. Section of Malpighian Corpuscles of Kidney of Human Fœtus.

PLATE LXVIII.

Fig. 150. Convoluted Tube of Kidney of Pig.
" 151. Section of Eyelash of newly-born Child.
" 152. Meibomian Follicle from Section of Human Eyelid.

PLATE LXIX.

Fig. 153. Tubular Glands of Human Prostate.
" 154. Section of Cortical Substance of Kidney of Six Months' Human Fœtus.
" 155. Tubular Glands of Human Eyelid; Vertical Section.

PLATE LXX.

Fig. 156. Cornea of Rabbit; Vertical Section.
" 157. Diagram of Connective Substance of Retina.
" 158. " Nervous Elements of Retina.

PLATE LXXI.

Figs. 159–163. Blastoderm of Egg of Trout, Various Stages of Cleavage in.
" 164. Germ of Egg of Trout in an early Stage of Cleavage.
" 165. Blastoderm of Egg of Trout at the Third Day; Vertical Section.
" 166. Similar Preparation at the Sixth Day.

PLATE LXXII.

Fig. 167. Blastoderm of Egg of Trout, Twelfth Day; Vertical Section.
" 169–172. Sections of Egg of Bufo Cinerus.

PLATE LXXIII.

Fig. 168. Blastoderm of Trout's Egg at Fourteenth Day.
" 173. Section through Rudiment of Embryo of Bufo Cinereus.

PLATE LXXIV.

Fig. 174. Section showing the Four Embryonal Coats of Rusconi's Cavity.
" 175. Blastoderm of Fresh-laid Hen's Egg.
" 176. Blastoderm of Hen's Egg at Fifteenth Hour of Incubation.
" 177. Section of Rudiment of Embryo at Twenty-sixth Hour after Incubation.

PLATE LXXV.

Fig. 178. Section of Rudiment of Embryo at Thirty-sixth Hour.
" 179. " Area Opaca and Area Pellucida at Thirtieth Hour.
" 180. Embryo of Chick at Thirtieth Hour; Section of Cervical Portion.

PLATE LXXVI.

Fig. 181. Embryo of Chick, Second Day, showing Development of the Heart.
" 187. Development of Blood in Blastoderm of Chick.

PLATE LXXVII.

Fig. 182. Embryo of Chick at Forty-eighth Hour; Section of Posterior Part of Body.
" 183. Section of Anterior Cerebral Vesicle and Primary Optic Vesicle.

PLATE LXXVIII.

Figs. 184–186. Transformation of Primary into Secondary Optic Vesicle and Development of Crystalline Lens.
" 188. Development of Blood in Chick.

PLATE LXXIX.

Fig. 190. Test Tube with Foot.
" 191. Vessel for collecting Blood and keeping it at 0° C.
" 192. Coagulation of Blood of Frog in a fine Capillary Tube.
" 193. Canula for Schäfers' Experiment.
" 194. Object Glass for Studying Action of Induction Shocks on Blood.

PLATE LXXX.

Fig. 195. Absorption Spectra.
" 196. Hoppe-Seyler's Bottle for Preparing Fibrin.
" 197. Alvergniat's Pump.
" 198. Geissler's Mercurial Pump.

PLATE LXXXI.

Fig. 199. Frankland-Sprengel Pump.
" 203. Needles for passing Ligatures under Vessels; Brücke's Blunt Hook; and Trephine.

PLATE LXXXII.

Fig. 200. Frankland's Apparatus for Analysis of Gases by Absorption.

PLATE LXXXIII.

Fig. 204. Czermak's Rabbit Support.
" 201. Frankland and Ward's Apparatus for Analysis of Gases by Explosion.

PLATE LXXXIV.

Fig. 202. Mercurial Kymograph.
" 206. Normal Tracing obtained with Mercurial Kymograph.

PLATE LXXXV.

Fig. 205. Fick's Spring Kymograph.
" 207. Normal Tracing obtained with Spring Kymograph.
" 207*a*. Tracing obtained after Excitation of Vagus.
" 208. Mechanical Arrangement of Sphygmograph.

PLATE LXXXVI.

Fig. 209. End View of Block by which Sphygmograph rests on the Wrist.
" 209*b*. Breguet's Improvement.
" 210. Mode of Measuring Pressure.
" 211. Arterial Schema.

PLATE LXXXVII.

Fig. 212. Tracing obtained with Arterial Schema.
" 213. Percussion Waves.
" 214. Tracings showing the Contractions and Expansions of an India-rubber Tube, along which Water is propelled in an Intermitting Stream.
" 215. Sphygmographic Tracings.
" 216. Dr. Caton's Fish Trough.

PLATE LXXXVIII.

Fig. 217. Stage for Mesentery of Frog.
" 218. Canulæ for Aorta and Vena Cava of Frog.
" 219. Diagram of Arrangement for Measuring Objects under Microscope.
" 220. Canula for Injecting Liquid into a Vein.
" 221. Griffin's Blower and Expanding Regulator.

PLATE LXXXIX.

Fig. 222. Sprengel's Blower.
" 223. Mercurial Breaker for Artificial Respiration.
" 224. Skull of Rabbit seen from behind.
" 225. Excitor.
" 226. Parts exposed in Rabbit by an Incision from Thyroid Cartilage to Root of Left Ear.

PLATE XC.

Fig. 227. Carotid Artery of Rabbit and Parts in relation with it.
" 228. Heart of Frog.
" 230. Cardiograph.
" 231. Marey's Tympanum and Lever.

PLATE XCI.

Fig. 233. Coats' Apparatus.

PLATE XCII.

Fig. 235. Tracings recording simultaneously Variations of Pressure in Right Auricle, Right Ventricle, and Left Ventricle.
" 236. Septum Auricularum of Frog.
" 237. Dissection of Vagus Nerve of Frog, right side.

PLATE XCIII.

Fig. 240. Sketch illustrating Relations of Ganglionic Cord in Visceral Cavity of Frog.
" 241. Heart, Lungs, and great Vessels of Rabbit.
" 242. Dissection of lower Cervical Ganglion of Dog.

PLATE XCIV.

Fig. 243. Inferior Cervical Ganglion of Rabbit.
" 244. Tracing showing Effect of Electrical Stimulation of Vagus of Frog under the Influence of Nicotin.
" 246. Respiratory Muscles of Frog.
" 247. Recording Stethometer.

PLATE XCV.

Fig. 250. Pulley for recording Movements of Needle inserted in the Diaphragm.
" 251. Rosenthal's Apparatus with W. Müller's Valves.
" 252. Pettenkofer's Tube for Absorption of Carbonic Acid Gas.

PLATE XCVI.

Fig. 257. Lever Kymograph.
" 258. Tracing obtained with Lever Kymograph.

PLATE XCVII.

Fig. 265. Calorimeter.
" " Galvanometer.
" " Wooden Frame on which Galvanometer Wire is coiled.
" " Magnets of Galvanometer.

PLATE XCVIII.

Fig. 229. Tracing drawn by Lever applied to Apex of Heart of Frog.
" 232*a*. " obtained with Cardiograph applied to Seat of Impulse of Human Heart.
" 232*b*. " obtained with Cardiograph applied outside Seat of Impulse of Human Heart.
" 234. " of Endocardial Pressure of Heart of Frog.
" 238*a* & *b*. Tracings of Arterial Pressure and Respiratory Movement of Air in Trachea before and after Section of both Vagi.
" 239*a* & *b*. Tracing of Arterial Pressure of Rabbit during Excitation of Peripheral End of Divided Vagus.
" 245. Tracing of Arterial Pressure during Excitation of Central End of Depressor Nerve.

PLATE XCIX.

Fig. 246*bis*. Tracing of Respiration of Frog.
" 248. " obtained with the Stethometer.
" 249. " of Intra-thoracic Pressure.
" 253. Tracings of Respiration of Cat, before and after Section of both Vagi.
" 263*a*. Tracing of Arterial Pressure and Respiratory Movements in Second Stage of Asphyxia by Occlusion.
" 263*b*. Slow Asphyxia.

PLATE C.

Figs. 259-61. Tracings of Respiratory Movements of Dog, before and after Curarization.
" 262. Tracings of Artificial Respiration and Arterial Pressure, showing Traube's Curves with Vagi intact.
" 264. Effect of Single Injection of Air in a Curarized Dog after Discontinuance of Artificial Respiration.

PLATE CI.

Figs. 254-55. Excitation of Central End of Vagus in the Rabbit.
" 256. Excitation of Central End of Superior Laryngeal Nerve.

PLATE CII.

Fig. 266. Diagram of Frog, showing Lines of Incision necessary in various Observations.
" 267 Diagram of Muscles of Leg of Frog.
" 268. Nerve-Muscle Preparation.

PLATE CIII.

Fig. 269. Myographion of Pflüger.
" 270. Moist Chamber, with Nerve-muscle Preparation.
" 270*bis*. Simple Spring Myograph of Marey.

PLATE CIV.

Fig. 271. Ordinary Electrodes.
" 272. Non-polarizable Electrode in Bearer.
" 273. Ends of Non-polarizable Electrodes.
" 274. Kronecker's Forceps.
" 275. Marking Lever.
" 276. Diagram of Apparatus for Studying the Effects of Electrotonus or Irritability.

PLATE CV.

Fig. 277. Recording Tuning-fork.
" 278. Diagram of Muscles of Thigh of Frog.
" 279. " " Muscle Curve.
" 280. Muscle in Trough bearing Levers, to show the Wave of Muscular Contraction.
" 281. Another arrangement of the Levers to show the Wave of Muscular Contraction.

PLATE CVI.

Fig. 282. Diagram of the Curve of Tetanus.
" 283. Curve of Tetanus, showing individual Contractions.
" 284. Curves illustrating Extensibility of a Muscle during Tetanus.
" 285. Muscles and Nerves arranged for the Experiment of the Rheoscopic Frog.

PLATE CVII.

Fig. 286. Sir W. Thomson's Galvanometer and Scale.
" 287. Galvanometer Shunt.
" 288. Diagram of "Natural" Current in Muscle.
" 289. Arrangement of Nerve on Non-polarizable Electrodes.
" 290. Diagram illustrating Electrotonus.

PLATE CVIII.

Fig. 291. Muscle and Nerves arranged to show Use of Electrotonic Changes in one Nerve as a Stimulus for another.
" 292. Apparatus to show the Effects of varying Temperatures on a Muscle.
" 293. Induction Apparatus of Du Bois Reymond.
" 294. Scheme of Du Bois Reymond's Induction Coil.

PLATE CIX.

Fig. 295. Diagram of Nervous System of Frog.
" 296. Brain of Frog seen from above.
" 297. Commutator.

PLATE CX.

Fig. 298. Rheochord.
" 299. Double Key.
" 300. Du Bois Reymond's Key.

PLATE CXI.

Fig. 301. Creatine Crystals.
" 302. Creatinine "
" 303. Nitrate of Hypoxanthine Crystals.
" 304. Hydrochlorate of Xanthine "
" 305. Uric Acid Crystals.

PLATE CXII.

Fig. 306. Starch Granules.
" 307. Nerves of Sub-maxillary and Sub-lingual Glands of Dog.
" 308. Veins of Sub-maxillary Gland.

PLATE CXIII.

Fig. 309. Nerves of Sub-maxillary Gland of Dog.

PLATE CXIV.

Fig. 310. Parts exposed in Operations on the Sub-maxillary Gland.
" 311. Gastric Canula seen in Section, and Key.
" 312. Taurine Crystals.
" 313. Hippuric Acid Crystals.

PLATE CXV.

Fig. 314. Cholesterin.
" 315. Bernard's Instrument for puncturing Fourth Ventricle.
" 316. Section of Rabbit's Head, showing direction of Instrument in order to puncture the Fourth Ventricle.

PLATE CXVI.

Fig. 317. Canula in temporary Pancreatic Fistula.
" 318. Diagram to show arrangements of Stitches in Thiry's Fistula.
" 320. Milk Globules.
" 321. Colostrum.

PLATE CXVII.

Fig. 322. Urea.
" 323. Nitrate of Urea.
" 324. Oxalate "
" 325. Blowpipe Flame.
" 326. Glass Tube drawn out to form a Pipette.
" 327. " " in order to seal it.
" 328. Beaker supported on Wire Gauze to prevent it from Cracking.
" 329. Apparatus to prevent Loss by Evaporation during prolonged Ebullition.

PLATE CXVIII.

Fig. 330. Saucepan used as Water-bath.
" 331. Bunsen's Gas Regulator as modified by Geissler.
" 332. Water-bath for evaporating at a constant Temperature.
" 333. Use of Syphon in Washing Precipitates.

PLATE CXIX.

Fig. 334. Screw-press.
" 335. Bunsen's Water Air-pump.
" 336. Plantamour's Funnel for keeping Fluids Hot during Filtration.
" 337 Dialyser of Gutta-percha.

PLATE CXX.

Fig. 338. Dialyser suspended in Water.
" 339. Hot-air Bath.
" 340. Bell-jar and Dish for drying and cooling Substances.
" 341. Method of drying Precipitates.
" 342. Platinum Triangle for Ignition.
" 343–4. Specific Gravity Bottles.
" 345. " " " for small Quantities of Fluid.

PLATE CXXI.

Fig. 346. Measuring Flask.
" 347. Test Mixture.

PLATE CXXII.

Fig. 348. Pipettes.
" 349. Mohr's Burette.

PLATE CXXIII.

Fig. 350. Stand for Burettes.
" 351. Elliptical Appearance of Surface of Liquid in Burette.
" 352. Erdmann's Float.
" 353. Saccharometer.

NOTE.

The letter-press descriptive of the illustrations in this work contains references to specific pages of the text. Inasmuch as the paging of this edition differs from that of the English edition, we subjoin a table in which the corresponding paging of the two editions is seen at a glance.

	Eng. Ed.	Am. Ed.
PLATE I.		
Fig. 1,	page 6,	see page 22
“ 2,	“ 14,	“ “ 31
PLATE II.		
Fig. 4,	“ 11,	“ “ 26
PLATE III.		
Fig. 5,	“ 16,	“ “ 31
“ 6,	“ 17,	“ “ 33
PLATE IV.		
Fig. 11,	“ 42,	“ “ 56
“ 19,	“ 108,	“ “ 121
PLATE V.		
Fig. 22,	“ 3,	“ “ 19
“ 23,	“ 5,	“ “ 21
“ 24,	“ 13–15,	“ “ 28–31
PLATE VI.		
Fig. 25,	“ 9,	“ “ 25
“ 7,	“ 23,	“ “ 38
PLATE VII.		
Fig. 26,	“ 27,	“ “ 42
“ 28,	“ 24,	“ “ 41
PLATE VIII.		
Fig. 30,	“ 29–112,	“ “ 44, 125
PLATE IX.		
Fig. 33,	“ 33,	“ “ 47
“ 34,	“ 29,	“ “ 44
PLATE X.		
Fig. 36,	“ 28,	“ “ 43
PLATE XII.		
Fig. 39,	“ 38,	“ “ 52
“ 40,	“ 40,	“ “ 54
PLATE XIII.		
Fig. 42,	“ 41,	“ “ 55
“ 41,	“ 38,	“ “ 52
PLATE XV.		
Fig. 48,	“ 44,	“ “ 58
“ 49,	“ 46,	“ “ 60
PLATE XVII.		
Fig. 53,	“ 44,	“ “ 58
“ 54,	“ 44,	“ “ 58
“ 8,	“ 33,	“ “ 47
PLATE XVIII.		
Fig. 56,	“ 34,	“ “ 48
PLATE XIX.		
Fig. 58,	“ 49,	“ “ 63
PLATE XX.		
Fig 59,	page 49,	see page 63
PLATE XXI.		
Fig. 60,	“ 50,	“ “ 64
PLATE XXII.		
Fig. 61,	“ 50,	“ “ 64
PLATE XXIII.		
Fig 42,	“ 50,	“ “ 64
PLATE XXIV.		
Fig. 63,	“ 53,	“ “ 66
“ 64,	“ 61,	“ “ 74
“ 15,	“ 56,	“ “ 69
“ 65,	“ 54,	“ “ 67
PLATE XXV.		
Fig. 68,	“ 61,	“ “ 74
“ 67,	“ 52,	“ “ 65
PLATE XXVI.		
Fig. 69,	“ 72,	“ “ 85
“ 70,	“ 72,	“ “ 85
PLATE XXVII.		
Fig. 71,	“ 69,	“ “ 82
“ 73,	“ 78,	“ “ 91
“ 74,	“ 78,	“ “ 91
PLATE XXVIII.		
Fig. 72,	“ 69,	“ “ 82
“ 75,	“ 78,	“ “ 91
PLATE XXIX.		
Fig. 76,	“ 78,	“ “ 91
“ 77,	“ 73,	“ “ 86
PLATE XXX.		
Fig. 79,	“ 78,	“ “ 91
“ 78,	“ 78,	“ “ 91
PLATE XXXI.		
Fig. 80,	“ 78,	“ “ 91
“ 81,	“ 78,	“ “ 91
PLATE XXXII.		
Fig. 83,	“ 78,	“ “ 91
“ 82,	“ 78,	“ “ 91
PLATE XXXIII.		
Fig. 84,	“ 77,	“ “ 91
“ 86,	“ 78,	“ “ 91
PLATE XXXIV.		
Fig. 87,	“ 79,	“ “ 92
“ 88,	“ 82,	“ “ 95

		Eng. Ed.			Am. Ed.
Plate XXXV.					
Fig. 89,	page	80,	see	page	94
Plate XXXVI.					
Fig. 90–91	"	83,	"	"	96
" 92,	"	83,	"	"	96
Plate XXXVII.					
Fig. 93,	"	79,	"	"	92
" 9,	"	37–83,	"	"	51, 96
Plate XXXVIII.					
Fig. 94,	"	83,	"	"	96
Plate XXXIX.					
Fig. 97,	"	79,	"	"	92
" 98,	"	118,	"	"	131
Plate XL.					
Fig. 99,	"	106,	"	"	119
" 100,	"	106,	"	"	119
Plate XLI.					
Fig. 103,	"	105,	"	"	118
Plate XLIII.					
Fig. 105,	"	126,	"	"	139
Plate XLIV.					
Fig. 109,	"	28,	"	"	43
" 109,	"	115,	"	"	128
Plate XLVI.					
Fig. 111,	"	112,	"	"	125
" 112,	"	112,	"	"	125
Plate XLVII.					
Fig 113,	"	112,	"	"	125
Plate XLVIII.					
Fig. 115,	"	111,	"	"	123
" 114,	"	112,	"	"	125
Plate L.					
Fig. 117,	"	114,	"	"	127
" 118,	"	114,	"	"	127
Plate LI.					
Fig. 119,	"	114,	"	"	127
Plate LII.					
Fig. 120,	"	114,	"	"	127
Plate LIII.					
Fig. 121,	"	115,	"	"	128
Plate LIV.					
Fig. 122,	"	115,	"	"	128
Plate LVI.					
Fig. 124,	"	114,	"	"	127
Plate LVII.					
Fig. 125,	"	114,	"	"	127
Plate LX.					
Fig. 129,	"	117,	"	"	130
Plate LXI.					
Fig. 130,	page	120,	see	page	133
" 132,	"	120,	"	"	133
" 133,	"	126,	"	"	139
Plate LXII.					
Fig. 134,	"	126,	"	"	139
" 135,	"	126,	"	"	139
Plate LXIII.					
Fig. 136,	"	124,	"	"	137
" 137,	"	124,	"	"	137
" 138,	"	122,	"	"	135
" 139,	"	120,	"	"	133
Plate LXIV.					
Fig. 140,	"	125,	"	"	138
" 141,	"	126,	"	"	139
Plate LXV.					
Fig. 143,	"	134,	"	"	146
" 142,	"	126,	"	"	139
" 144,	"	134,	"	"	146
Plate LXVI.					
Fig. 145,	"	134,	"	"	146
Plate LXVII.					
Fig. 146,	"	132,	"	"	144
" 148,	"	132,	"	"	144
" 149,	"	132,	"	"	144
Plate LXVIII.					
Fig. 150,	"	132,	"	"	144
" 151,	"	131,	"	"	144
" 152,	"	131,	"	"	144
Plate LXIX.					
Fig. 153,	"	137,	"	"	149
" 154,	"	132,	"	"	144
Plate LXX.					
Fig. 156,	"	138,	"	"	150
" 158,	"	142,	"	"	154
Plate LXXI.					
Fig. 159,	"	148,	"	"	159
" 160,	"	148,	"	"	159
" 161,	"	148,	"	"	159
" 162,	"	148,	"	"	159
" 163,	"	148,	"	"	159
Plate LXXII.					
Fig. 169–172,	"	152,	"	"	163
Plate LXXIII.					
Fig. 173,	"	153,	"	"	164
Plate LXXV.					
Fig. 178,	"	156,	"	"	168
Plate LXXVII.					
Fig. 183,	"	157,	"	"	168
Plate CX.					
Fig. 298,	"	347,	"	"	354

Plate I.

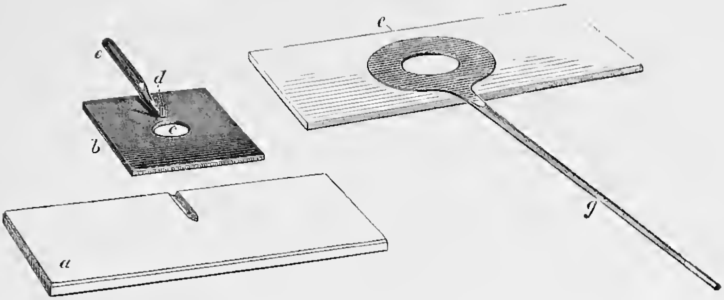


Fig. 1.—Simple arrangement for warming an object under the microscope. It consists of a copper plate (*e*) with a central orifice which is cemented to a common object-glass. From the edge of the plate a copper rod (*g*) projects, the end of which can be heated by a spirit lamp. p. 6.

Fig. 12.—A similar but more complicated apparatus. The copper plate *b* is square. The rod *e* projects from its under surface (upper as seen in the drawing), and fits in a groove cut in the glass. The groove ends in a hole into which the pin *d* fits.

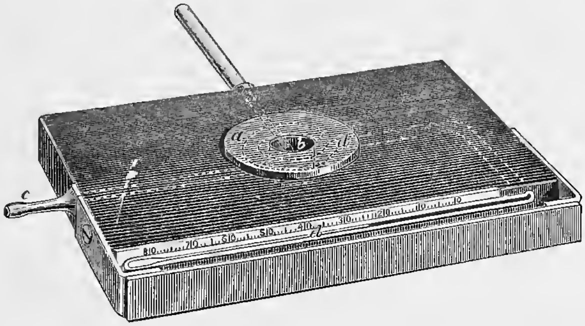
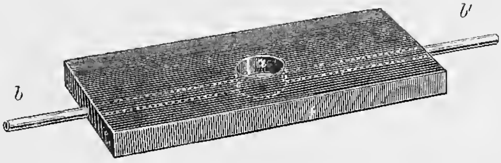


Fig. 2.—Stricker's warm stage (simple form). It consists of a block of black vulcanite about 3 inches long by 1½ wide, and ¼ inch thick. The central chamber (*b*) is closed below by a glass plate, and surrounded at the top by a perforated copper dish (*a*), the orifice of which is of the same size as the chamber. The chamber is cylindrical. The cistern of the thermometer surrounds the chamber, as shown by the dotted line (*d*). Its capillary tube lies in a trough, one side of which is formed by the back of the block and the other by a metal plate screwed on to it, the form of which is shown in the figure. The tube (*c*) leads into the chamber. A second tube leads from it through the projecting metallic arm shown at the top of the figure. This arm, which is of one piece with the disk (*a*), is of such size that the rod, fig. 13, fits on to it. By means of this rod the chamber is heated in the way already explained. In experiments with gases the gas enters by *c* and passes out through the projecting arm. p. 14.



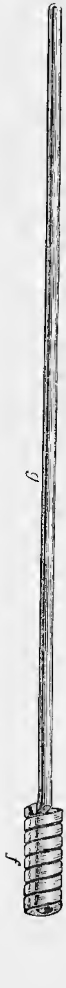


Fig. 13.—A rod *g*) intended to fit on the projecting arm of fig. 2 by means of a spiral (*f*). It answers the same purpose as (*g*) in fig. 1. A similar but much lighter rod is used for fig. 12.

Fig. 16. Object support of black vulcanite, measuring 3 inches by 1, with central gas chamber *a*. The gas enters and passes out by the tube *b b'*. The block when in use is fixed with putty on to an ordinary object-glass, and the chamber closed at the top with a cover-glass.

Plate II.

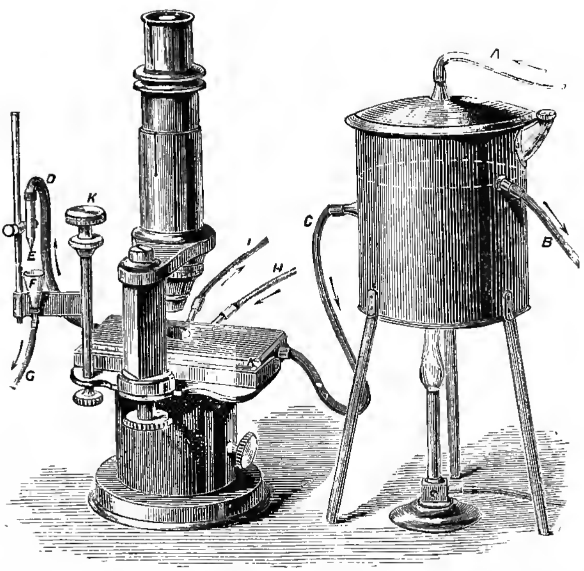


FIG. 3.—Stricker's warm stage. In the vessel A B C the water is maintained at a constant level (indicated by the dotted line), and at boiling temperature. A, supply tube; B, waste tube; C, tube leading to the stage; D, tube by which the hot water leaves the stage, terminating in a conical dropper, E; F, funnel for collecting the drops which fall from E; G, waste. The rate of flow is determined by varying the height of E, by means of the sliding screw on which it is supported. It admits of more exact adjustment by means of a fine screw which works in the axis of the vertical column, on which the escape tube is supported. This column is firmly fixed in the stage of the microscope; its axial screw terminates above in a milled head, K.

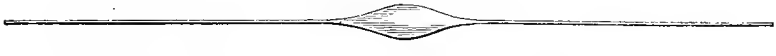


FIG. 4.—Capillary pipette. p. 11.

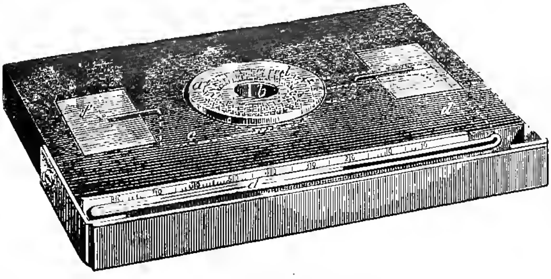


FIG. 14.—A similar stage by Stricker, in which the chamber *b* is warmed by a voltaic current. *f f* are two copper plates to which Stricker's electrodes, represented in fig. 6, are applied. *c*. A platinum wire by which these two plates are in communication. It coils round the cistern of the thermometer *d*. The electrodes are in connection with the opposite poles of a suitable battery, the elements of which must present a large surface.

PLATE III.

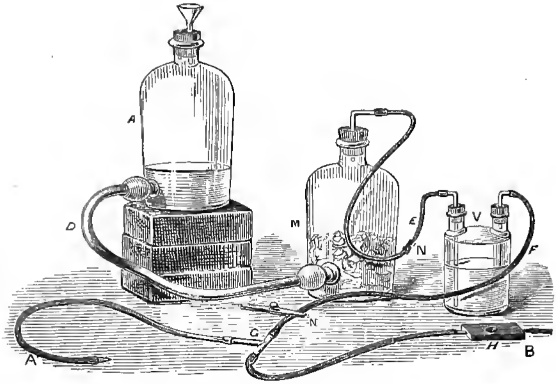


FIG. 5.—Carbonic acid apparatus. A. Bottle containing hydrochloric acid. M. Bottle containing fragments of marble on a stratum of broken glass. V. Wash-bottle. H. Object support, fig. 16. G. T-tube which communicates with the gas apparatus by the tube F, which is guarded by a clip, and in the opposite direction with H. By its stem it is in direct communication with the mouth of the operator by a tube on which there is also a clip. When the first clip is closed, carbonic acid collects in M and drives back the hydrochloric acid into A; a current of air can then be drawn through G and H. If the clip on the mouth-tube is closed and that on F opened, carbonic acid passes through H. p. 16.

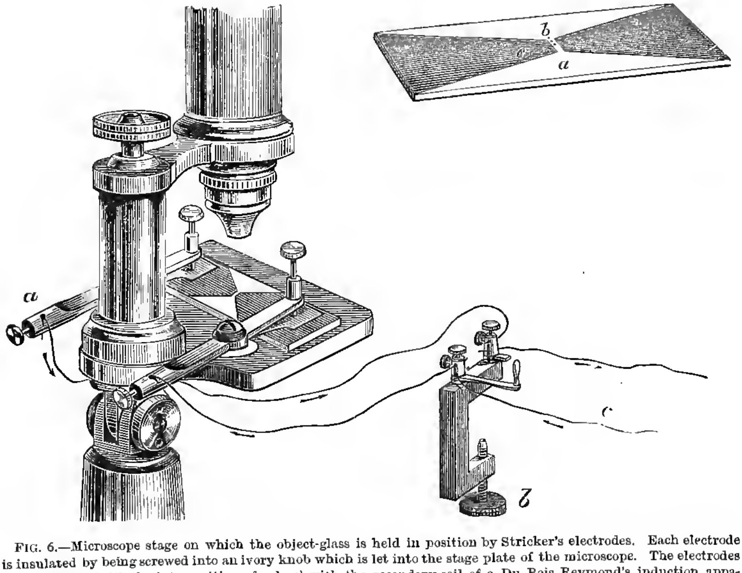


FIG. 6.—Microscope stage on which the object-glass is held in position by Stricker's electrodes. Each electrode is insulated by being screwed into an ivory knob which is let into the stage plate of the microscope. The electrodes are connected (with the interposition of a key) with the secondary coil of a Du Bois Reymond's induction apparatus. The key is represented open. The upper surface of the object-glass is covered with tinfoil, leaving a space, *b*, for the reception of the object. p. 17.

Plate IV.

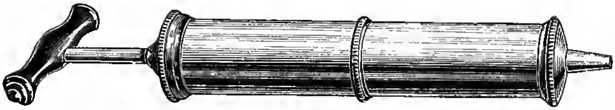
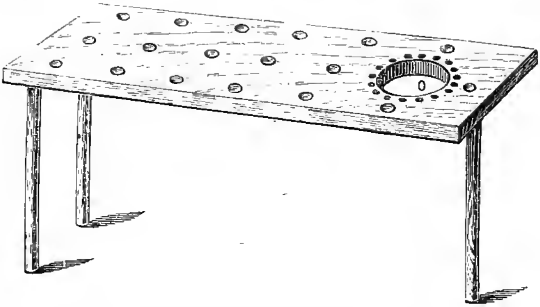


Fig. 17.—Injection syringe, one-third of the actual size.



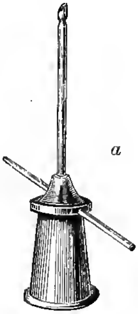
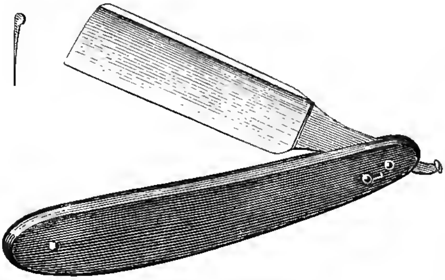


Fig. 11.—Support for the study of the circulation in the web of the frog. It must be so arranged that the large hole is just opposite the stage aperture of the microscope. (*See* description in text, p. 42.) It may also be used for the study of the tongue. For this purpose half of a ring of cork must be fixed with brass pins round the hole on the side next the end of the board. To this cork the cornua of the tongue may be attached.



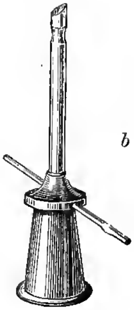
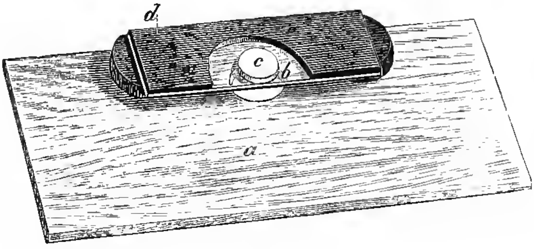


Fig. 20.—*a* & *b*. Injection cannulas, actual sizes.

Fig. 21.—Section knife. In the left-hand corner transverse section of the blade.



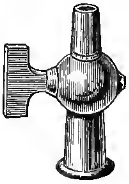


Fig. 18.—Nozzle of injection syringe, actual size.

Fig. 19.—Support for studying the circulation in the mesentery of the frog. *a*. Board on which the frog lies. *c*. Glass disk on which the mesentery rests. *b*. Trough for the reception of the coil of intestine. *d*. Object-glass covered with cork. [In the text, p. 108, *b* and *c* are transposed.]

PLATE V.

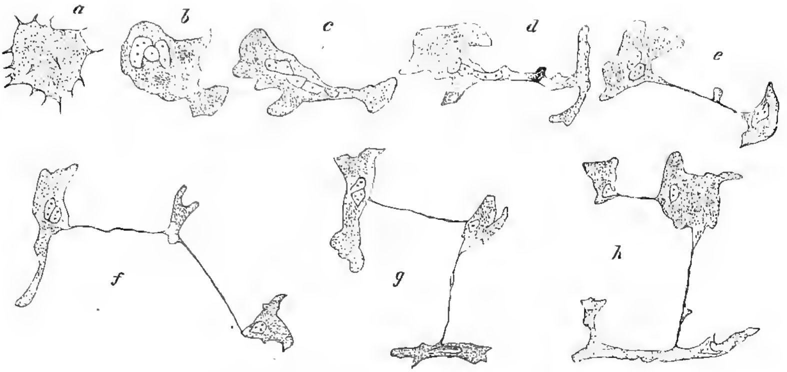


FIG. 22.—Common large colourless corpuscle of the newt. *a* to *h*. Successive forms assumed by the same cell in the course of an hour, in a preparation enclosed in oil, without the addition of any reagent. p. 3. (Hartnack: Ocular, No. 3; Objective, No. 8.)

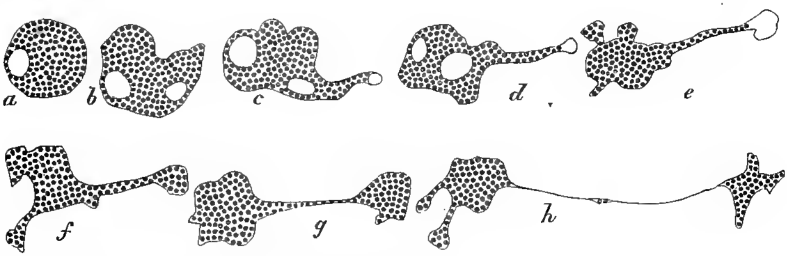


FIG. 23.—A granular corpuscle in the same preparation. *a* to *h*. Successive forms assumed by the same cell in the course of fifteen minutes. p. 5. (Ocular, No. 3; Objective, No. 8.)

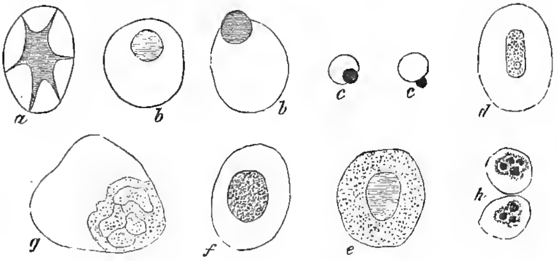


FIG. 24.—*a* and *b*. Coloured blood corpuscle of the newt, after the addition of 2 per cent. boracic acid, showing the zooid and œcoid. *c*. Coloured corpuscle of human blood, after the addition of 2 per cent. tannin solution, showing the zooid and œcoid. *d*. Coloured corpuscle of newt's blood, after the addition of diluted acetic acid. *e*. The same, treated with water, and then subjected to the action of CO_2. *f*. The same. A small quantity of CO_2 has been added to it, after it had been rendered pale by treatment with water. *g*. Colourless corpuscle of newt's blood, after the addition of dilute acetic acid. *h*. Colourless corpuscle of human blood, after the addition of dilute acetic acid. pp. 13-15. (Oc., 3; Obj., 8.)

Plate VI.

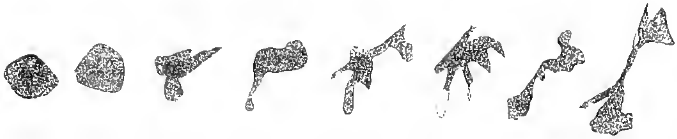


FIG. 25.—Oil preparation of human blood, as observed on the warm stage. A colourless blood corpuscle is seen, showing the changes of form it has undergone in twenty minutes. p. 9. (Hartnack: Ocul., 3; Obj., 8.)

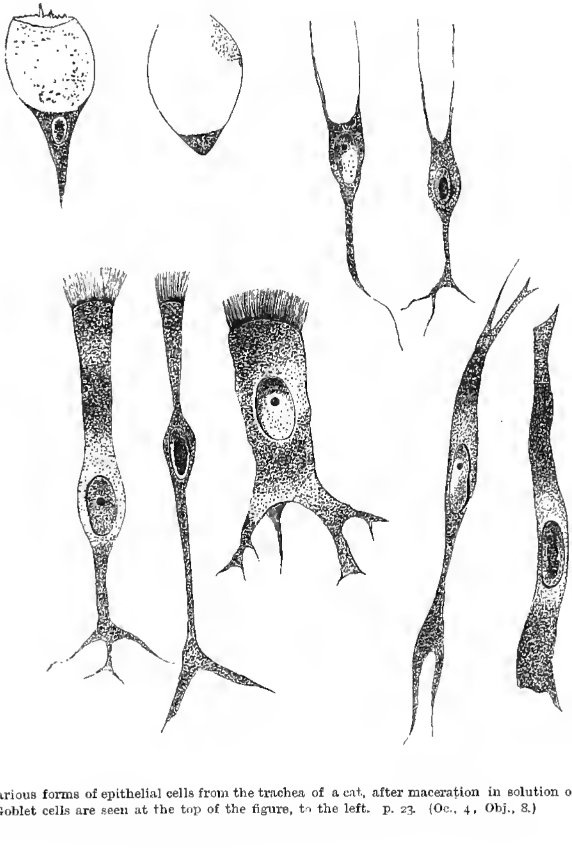


FIG. 7.—Various forms of epithelial cells from the trachea of a cat, after maceration in solution of bichromate of potash. Goblet cells are seen at the top of the figure, to the left. p. 23. (Oc., 4, Obj., 8.)

PLATE VII.

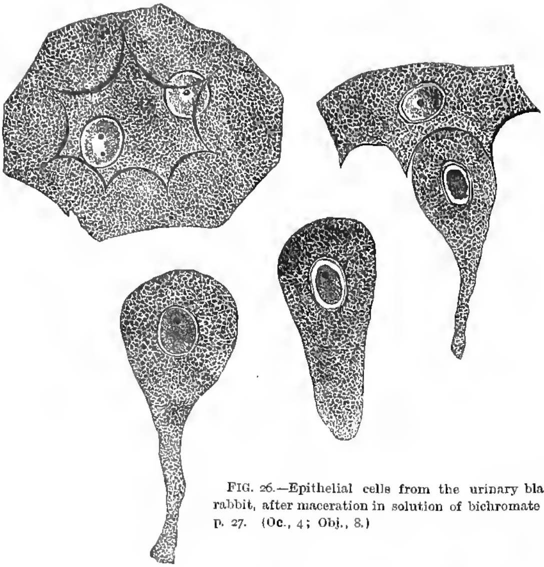


FIG. 26.—Epithelial cells from the urinary bladder of a rabbit, after maceration in solution of bichromate of potash. p. 27. (Oc., 4; Obj., 8.)

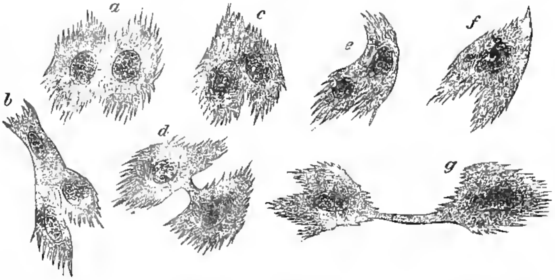


FIG. 27.—Epithelial cells (ridged cells) of the rete malpighii from a pointed condyloma, macerated in solution of bichromate of potash. The cells are in various stages of division. (Oc., 3; Obj., 8.)

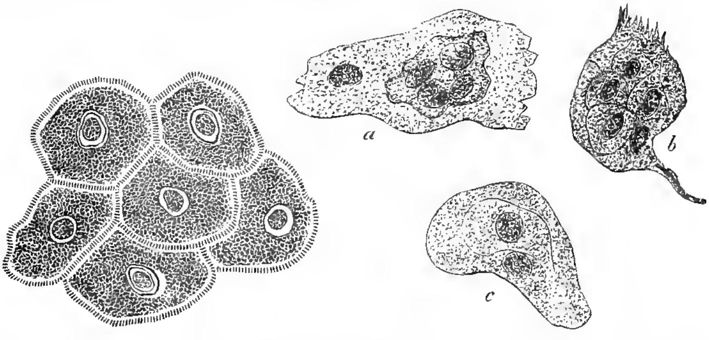


Fig. 28.—Superficial cells of the same preparation. Endogenous proliferation is seen at *a* and *c*. p. 26. (Oc., 3; Obj., 8)

Fig. 29.—Jagged cells of the middle layers of pavement epithelium from a vertical section of the gum of a new-born infant, hardened in chromic acid. (Oc., 3; Obj., 8.)

Plate VIII.

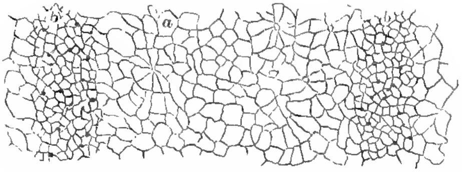


FIG. 30.—Abdominal surface of centrum tendineum of rabbit, slightly coloured with silver. *a*. Endothelium of the serosa where no lymph vessel is seen. *b*. The same, showing an interfascicular lymph channel underlying the endothelium, in which a capillary lymph vessel runs. *c*. A "stoma" (?). pp. 29, 112. (Oc., 2; Obj., 4.)

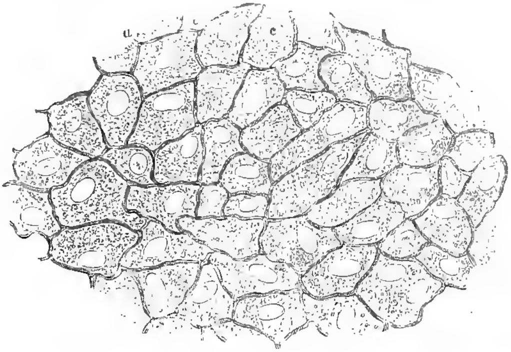


FIG. 31.—Pleural surface of centrum tendineum of rabbit, more strongly coloured with silver. *a*. Dark silver lines of the interstitial substance of the endothelial cells; *b*. cell substance; *c*. nucleus. (Oc., 3; Obj., 5.)

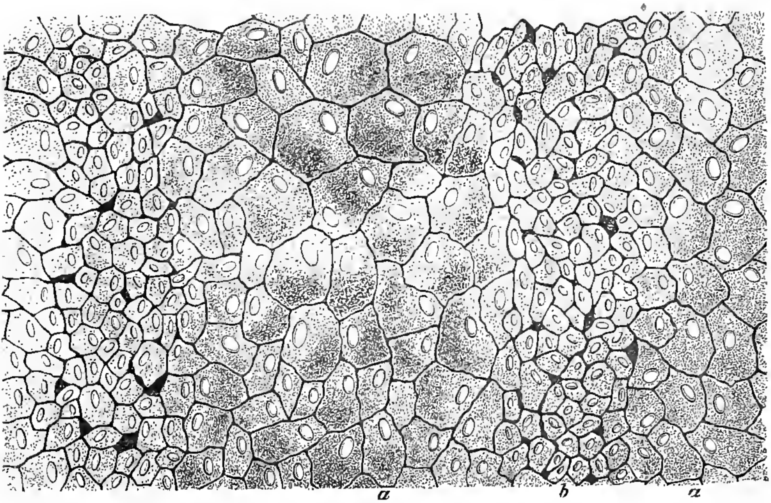


FIG. 32.—The same as fig. 30, still more intensely coloured. (Oc., 3; Obj., 7.)

PLATE IX.

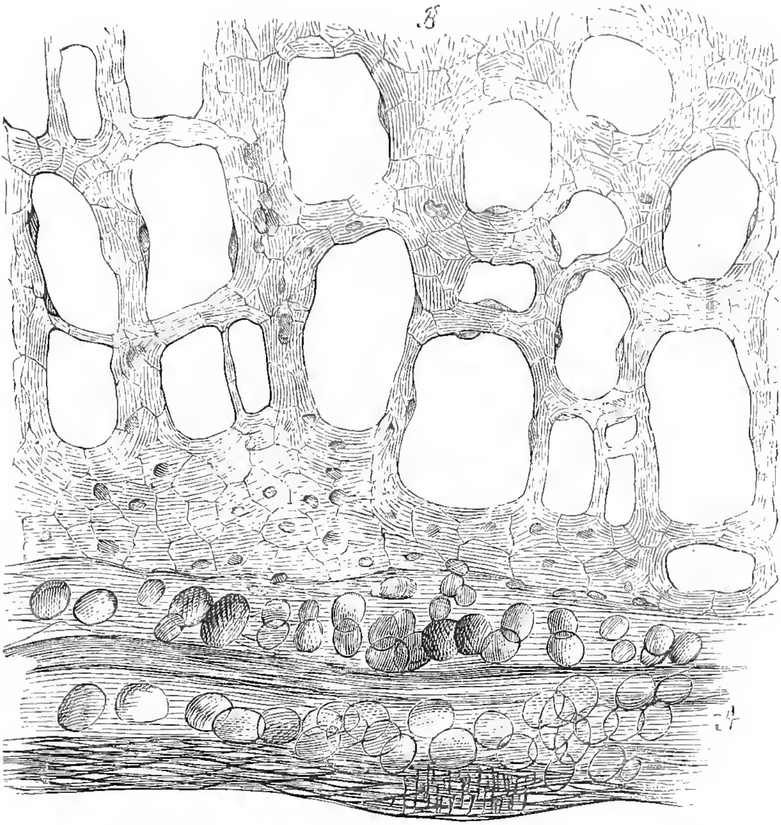


FIG. 33.—Omentum of guineapig treated with silver. A. One of the principal trabeculæ, containing blood-vessels and fat cells. B. Fenestrated portion, the trabeculæ of which are covered with flat endothelium. p. 33, where it is referred to as fig. 8. (Oc., 3; Obj., 7. Tube of the microscope not drawn out.)

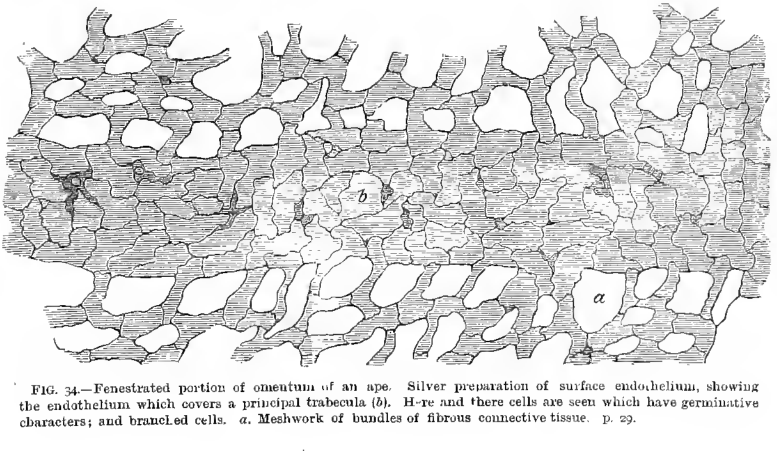


FIG. 34.—Fenestrated portion of omentum of an ape. Silver preparation of surface endothelium, showing the endothelium which covers a principal trabecula (*b*). Here and there cells are seen which have germinative characters; and branched cells. *a*. Meshwork of bundles of fibrous connective tissue. p. 29.

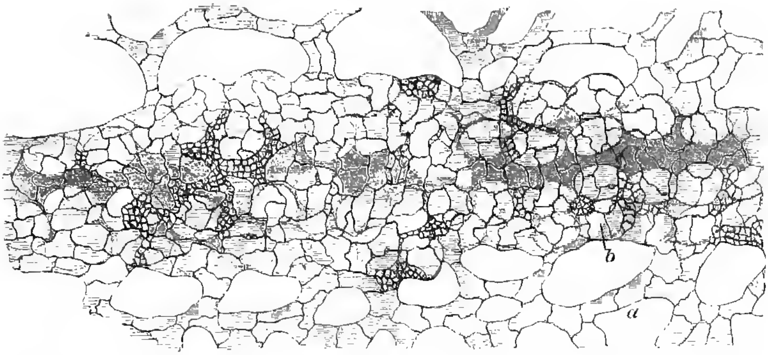


FIG. 35.—A similar preparation from the same omentum as fig. 34, showing groups of germinating endothelial cells amongst the ordinary large endothelial elements which cover the trabecula (*b*).
(In Figs. 34 and 35, Oc. 3, Obj. 5. Tube half drawn out.)

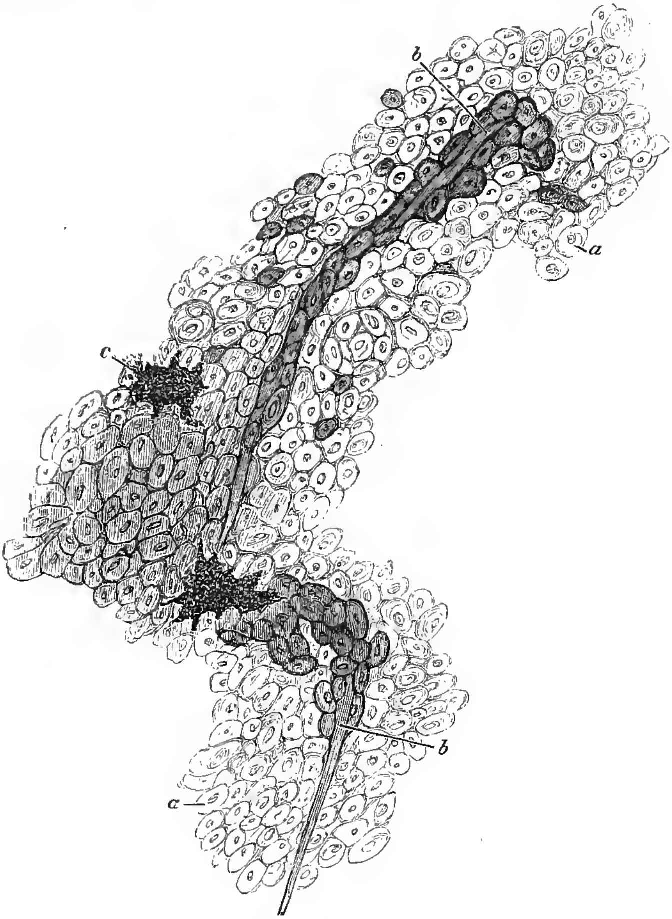


FIG. 36.—Silver preparation of the septum of the *cisterna lymphatica magna* in a female frog. *a*. Endothelial elements of peritoneal surface having germinating characters. *b*. A free trabecula projecting above the surface, covered with germinating endothelium. *c*. Pigment cells. p. 28. (Oc., 3; Obj., 8. Tube not drawn out.)

PLATE XI.

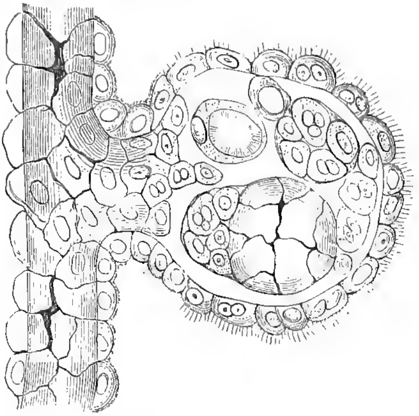


FIG. 38.—Bud-shaped structure of mesogastrium of frog, treated with silver, covered with ciliated polyhedral germinating endothelium. In the ground-substance of the bud-shaped structure are groups of young amœboid cells; and in addition to these are vacuole cells beset with cilia on their internal surface—*i.e.* that turned towards the cavity of the vacuole. There is also a large vacuole cell, the wall of which has become changed into endothelium. (Oc., 3; Obj., 8.)

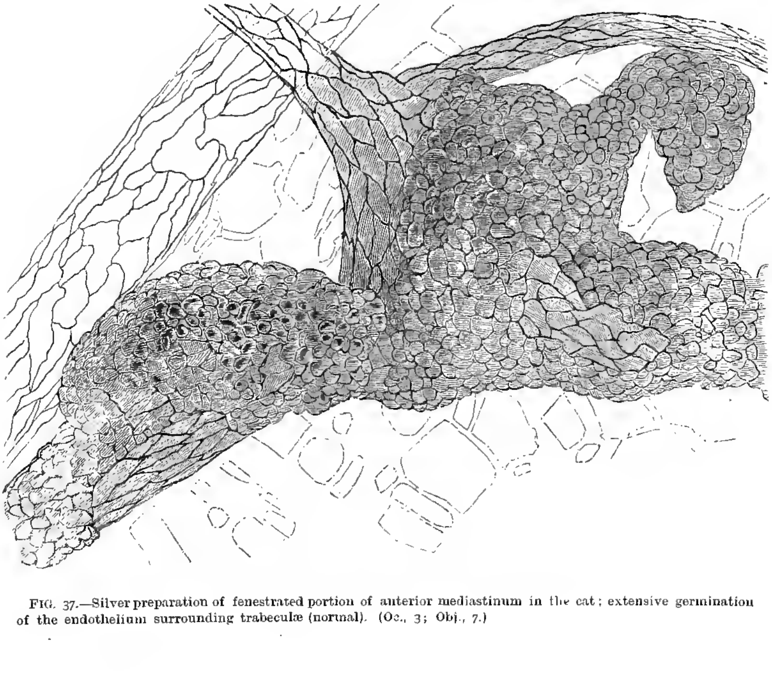


FIG. 37.—Silver preparation of fenestrated portion of anterior mediastinum in the cat; extensive germination of the endothelium surrounding trabeculæ (normal). (Oc., 3; Obj., 7.)

PLATE XII.

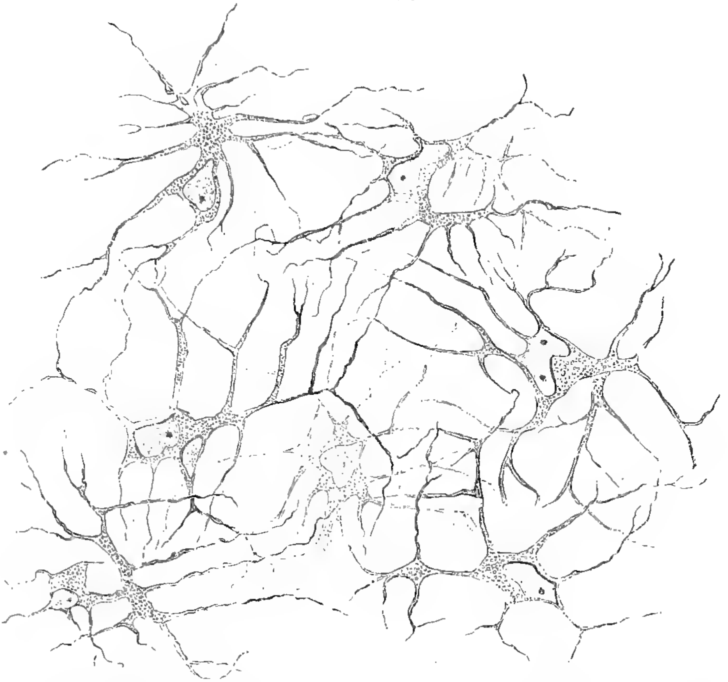


FIG. 40.—Horizontal preparation of cornea of frog coloured with chloride of gold, showing the network of branched cornea corpuscles. The ground-substance is completely colourless. p. 40, referred to as fig. 10. (Oc., 3; Obj., 8.)

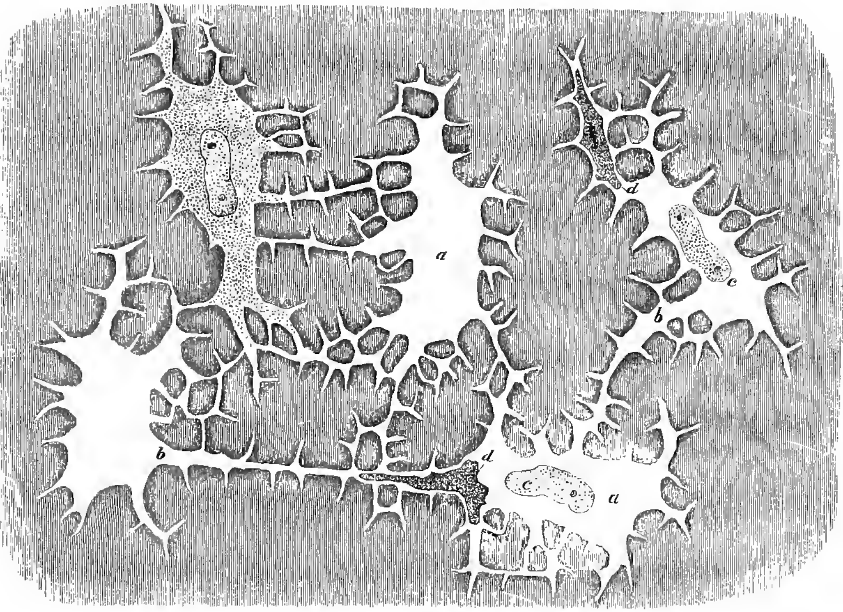


FIG. 39.—Cornea of frog treated with lunar caustic. *a*. Canalicular system (*Saftkanalsystem*). In one place a branched, flattened cornea corpuscle with its nucleus is seen; in two others are lacunæ of the canalicular system, and nuclei (*c*) of the cornea corpuscles. *d* Migratory cells. *b*. Branched channels which connect the lacunæ of the canalicular system. Ground-substance dark. p. 38. (Oc., 3; Obj., 9. Immersion.)

PLATE XIII.

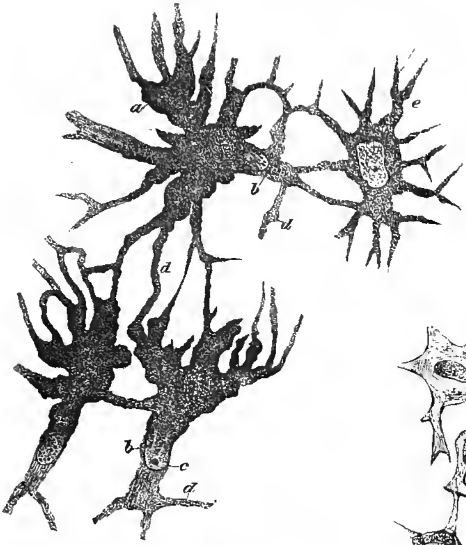


FIG. 42.—Membrana nictitans of frog, treated with chloride of gold. *a.* Branched pigment cells. *b.* Unpigmented portion of the body of the cell. *d.* Unpigmented process. *c.* Nucleus of pigment cell. *e.* Ordinary unpigmented branched flattened cell. p. 41. (Oc., 4; Obj., 10; immersion—reduced to about half.)

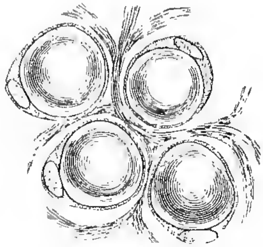


FIG. 45.—Ordinary fat cells of a fat tract in the omentum of a rat. (Oc., 3; Obj., 7.)

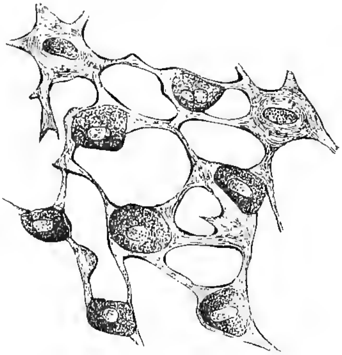
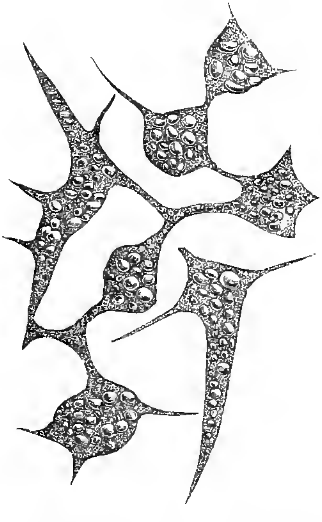


FIG. 43.—Surface of chronically inflamed mesentery of ape, pencilled and treated with silver. Canalicular system: Migratory cells are seen upon the flat branched cells, which, on account of their nuclei and size, are probably not to be regarded as colourless blood corpuscles. (Oc., 3; Obj., 8. Tube not drawn out.)



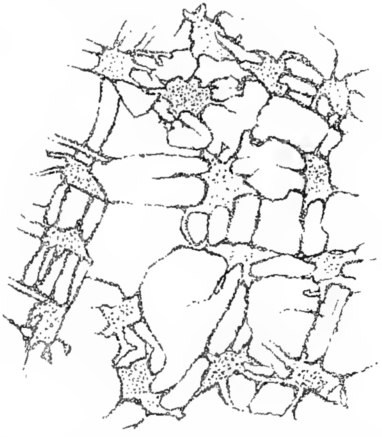


FIG. 44.—The same preparation, showing the branched cells of the canalicular system filled with fat globules. (Oc., 3; Obj., 8.)

FIG. 41.—Horizontal preparation of cornea of rabbit, treated first with lunar caustic, and afterwards placed in 10 per cent. saline solution. Ground-substance clear, while the canalicular system is marked out by a dark granular precipitate. This appearance, and that shown in fig. 39, have the same relation to each other as the positive to the negative of a photograph. p. 38. (Oc., 3; Obj., 7. Tube not drawn out.)

PLATE XIV.

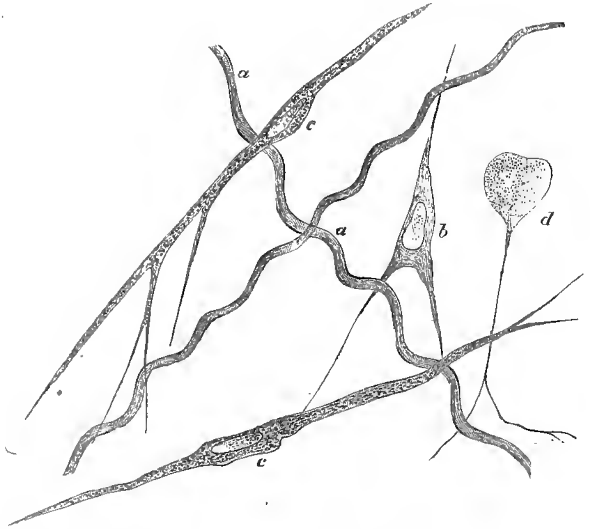


FIG. 46.—Gelatinous substance of infra-orbital fossa of rabbit, freshly prepared in serum. *a*. Bundles of connective tissue. *b*. Flat branched cells. *c*. The same seen in profile. *d*. Cells of doubtful character

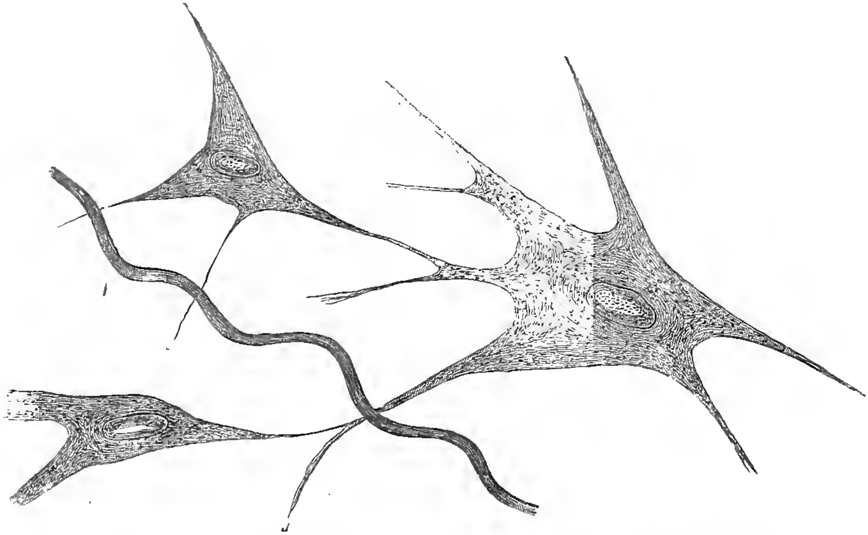


FIG. 47.—Cells of the same preparation seen from the surface. They appear as flat, branched cells with oblong nuclei. The protoplasm of the cells is distinctly fibrillated. (Oc., 3; Obj., 9; immersion in both these figures.)

PLATE XV.

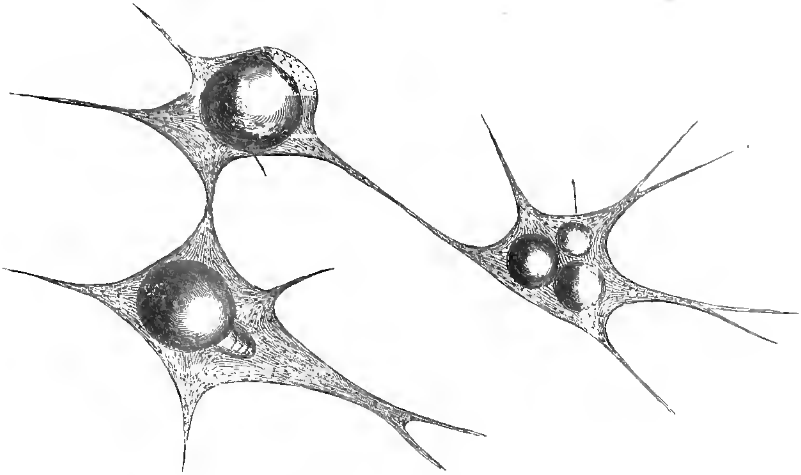


FIG. 48.—The same cells as in fig. 47 being converted into fat cells. p. 44. (Oc., 3; Obj., 9 ; immersion.)

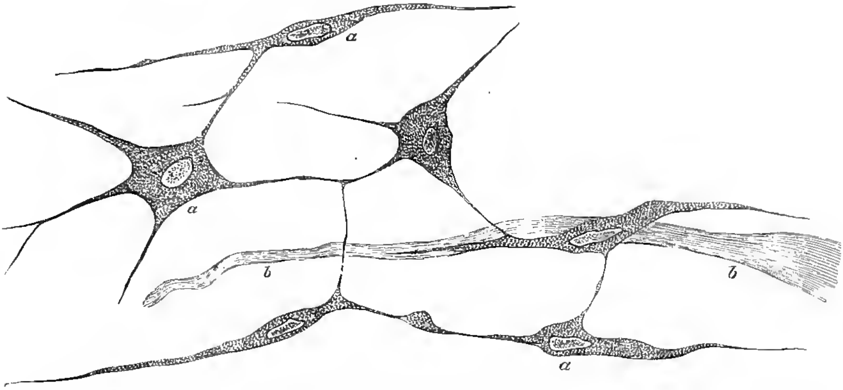


FIG. 49.—Portion of submucous tissue of gravid uterus of sow, macerated in bichromate of potash. *a*. Branched cells, more or less spindle-shaped. *b*. Bundles of connective tissue. p. 46. (Oc., 3; Obj., 8. Tube half drawn out.)

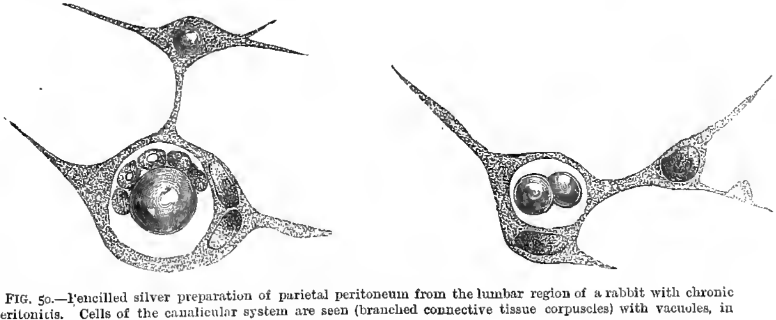


FIG. 50.—Pencilled silver preparation of parietal peritoneum from the lumbar region of a rabbit with chronic peritonitis. Cells of the canalicular system are seen (branched connective tissue corpuscles) with vacuoles, in which are fat cells and young amœboid cells. (Oc., 3; Obj., 8.)

PLATE XVI.

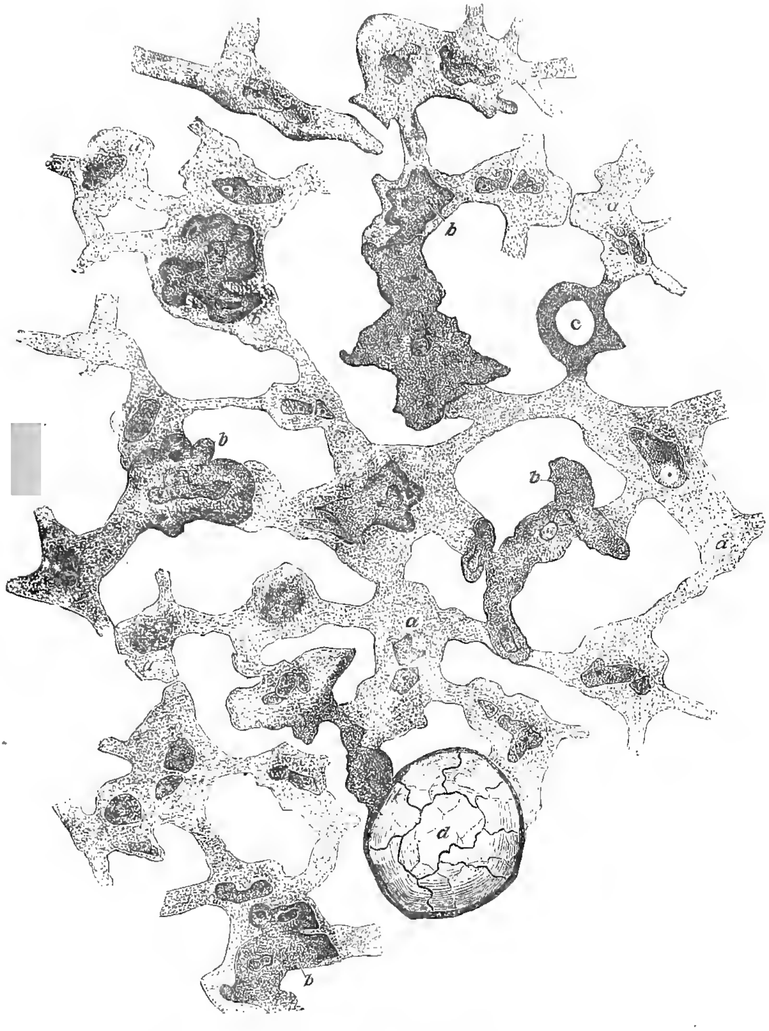


FIG. 51.—Preparation of surface of omentum of rabbit, pencilled and treated with silver. *a*. The flat branched cells of the canalicular system are visible as finely granular structures; their nuclei are sharply defined, and in several places are seen in the act of dividing. *b*. Migratory cells, some of which are free, while others grow out from the flat cells of the canalicular system, like buds; in one of the latter, the formation of a vacuole is seen at *c*. *d*. A vacuole cell, the wall of which is already changed into endothelial elements. (Oc., 3; Obj., 9, Immersion.)

PLATE XVII.

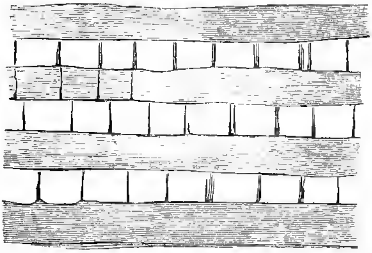


FIG. 52.—Caudal tendon of a young rat, pencilled and treated with silver. The spaces occupied by the tendon cells are clear, while the intercellular interstitial substance is seen as dark lines.

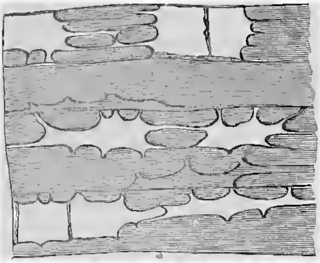


FIG. 53.—Similar preparation from a fall grown rat. p. 44. (Oc., 3; Obj., 7.)

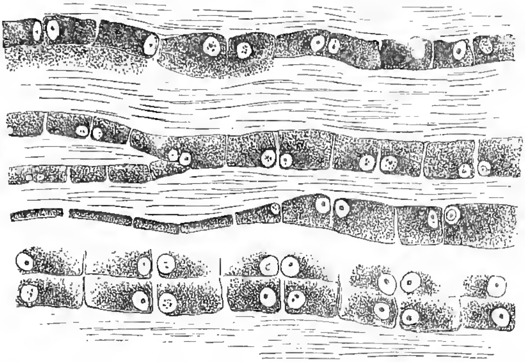


FIG. 54.—Caudal tendon of young rat, treated first with dilute acetic acid, and then with chloride of gold showing the arrangement, form and structure of the tendon cells. p. 44. (Oc., 2; Obj., 8.)

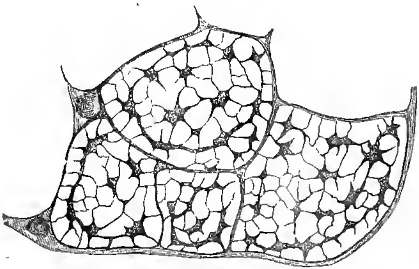


FIG. 55.—Transverse section of tendon from a cross section of the tail of a rabbit. (Magnifying power about 250.)

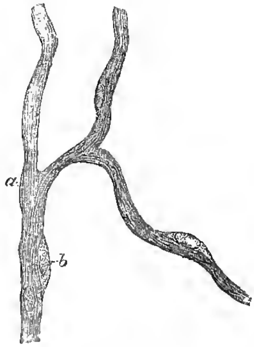


FIG. 8.—Fresh saline solution preparation o connective tissue trabeculæ from the fenestrated portion of the omentum of a guineapig. *a*, Bundles of connective tissue. *b*, Endothelial cells seen in profile. p. 33. (Oc., 3; Obj., 7.)

PLATE XVIII.

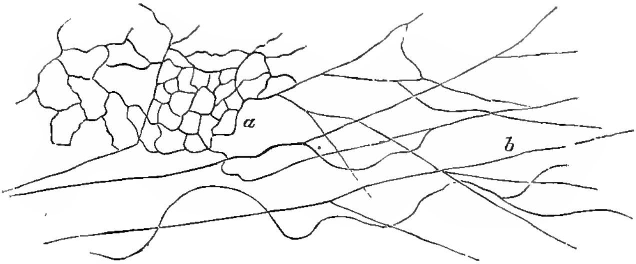


FIG. 50.—Network of elastic fibres from the fresh mesentery of a rabbit, treated with dilute acetic acid. In *a* the network is more superficial than in *b*. p. 34. (Oc., 3; Obj., 7.)

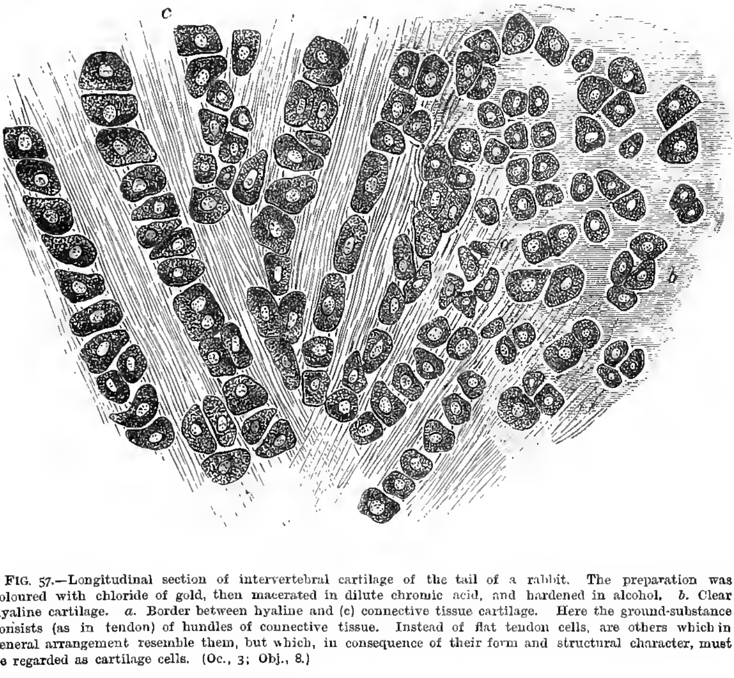


FIG. 57.—Longitudinal section of intervertebral cartilage of the tail of a rabbit. The preparation was coloured with chloride of gold, then macerated in dilute chromic acid, and hardened in alcohol. *b*. Clear hyaline cartilage. *a*. Border between hyaline and (c) connective tissue cartilage. Here the ground-substance consists (as in tendon) of bundles of connective tissue. Instead of flat tendon cells, are others which in general arrangement resemble them, but which, in consequence of their form and structural character, must be regarded as cartilage cells. (Oc., 3; Obj., 8.)

PLATE XIX.

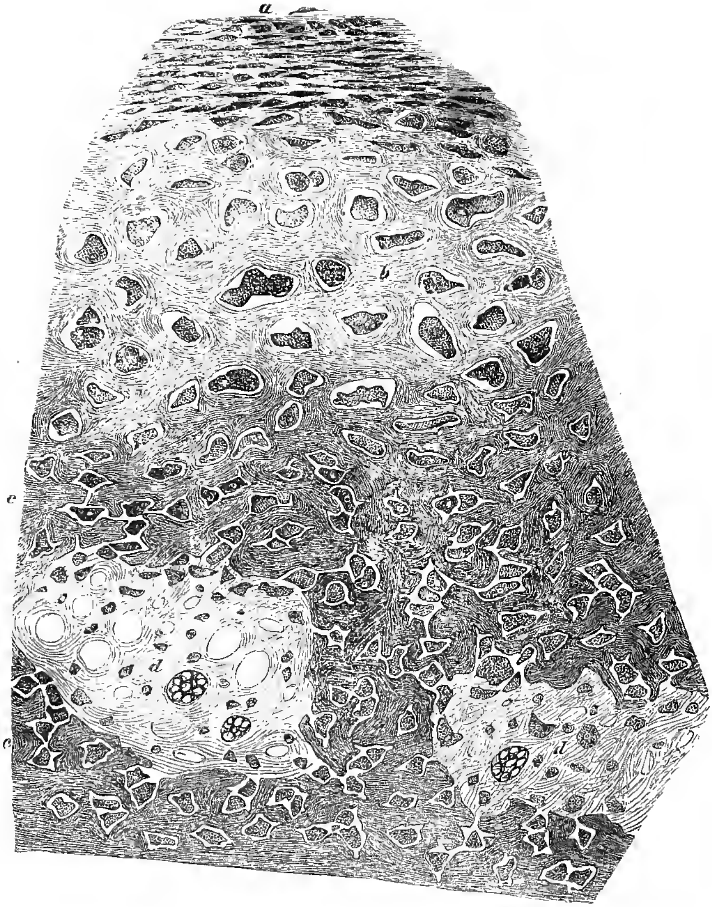


FIG. 58.—Transverse section of a portion of the epiphysis in the neighbourhood of the diaphysis of the femur of a human fœtus, macerated in chromic acid. This part is still covered with hyaline cartilage. *a*. Superficial portion of hyaline cartilage. *b*. The same, with large cartilage cells, the intercellular substance of which at *c* is undergoing transition into embryonal bone trabeculæ *e*. *d*. Fine fibrous tissue, rich in cell elements and blood-vessels, found in the mesh-work of the bone trabeculæ. p. 49. (Oc., 3; Obj., 7.)

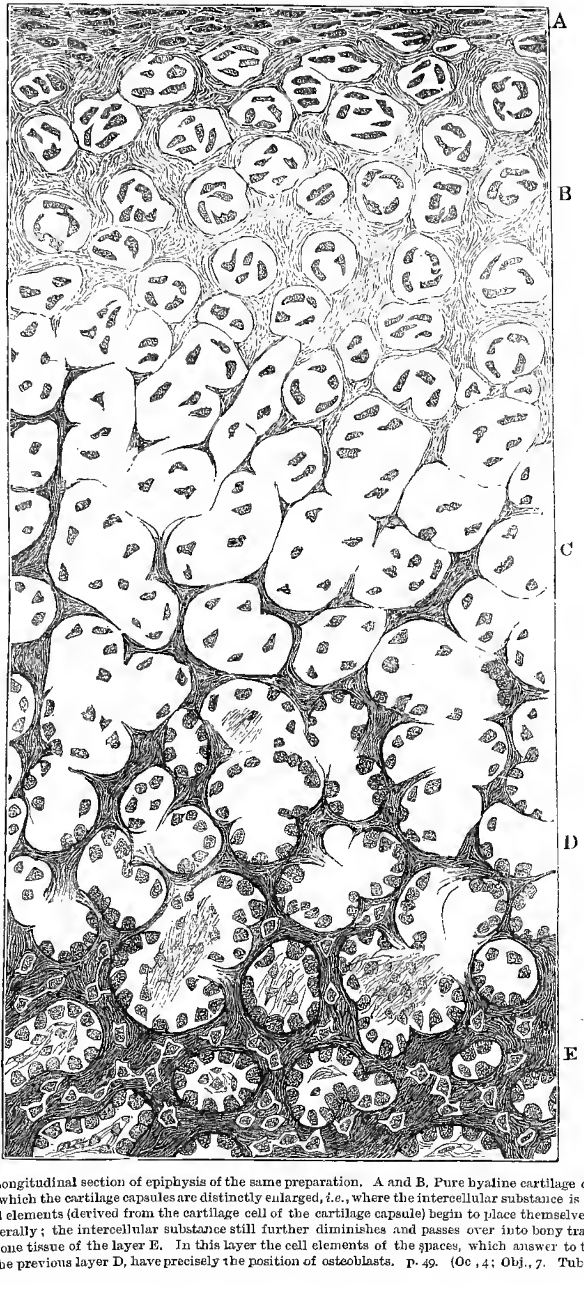


FIG. 59.—Longitudinal section of epiphysis of the same preparation. A and B. Pure hyaline cartilage of the joint. C. Layers in which the cartilage capsules are distinctly enlarged, *i.e.*, where the intercellular substance is diminished. At D the cell elements (derived from the cartilage cell of the cartilage capsule) begin to place themselves in regular order peripherally; the intercellular substance still further diminishes and passes over into bony trabeculæ—the embryonal bone tissue of the layer E. In this layer the cell elements of the spaces, which answer to the cartilage capsules of the previous layer D, have precisely the position of osteoblasts. p. 49. (Oc., 4; Obj., 7. Tube not drawn out.)

PLATE XXI.

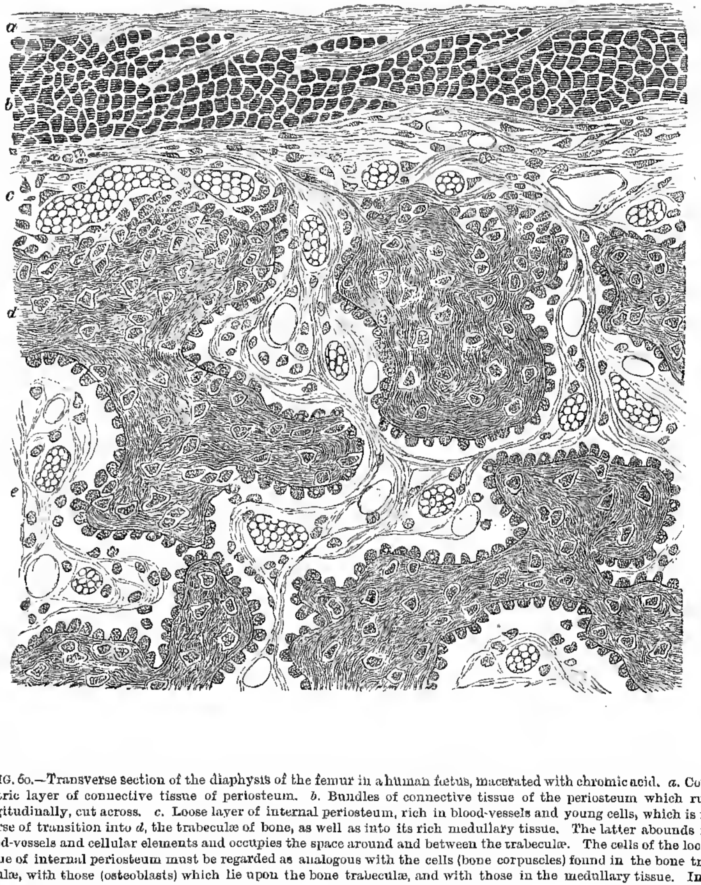


FIG. 60.—Transverse section of the diaphysis of the femur in a human fœtus, macerated with chromic acid. *a.* Concentric layer of connective tissue of periosteum. *b.* Bundles of connective tissue of the periosteum which run longitudinally, cut across. *c.* Loose layer of internal periosteum, rich in blood-vessels and young cells, which is in course of transition into *d*, the trabeculæ of bone, as well as into its rich medullary tissue. The latter abounds in blood-vessels and cellular elements and occupies the space around and between the trabeculæ. The cells of the loose tissue of internal periosteum must be regarded as analogous with the cells (bone corpuscles) found in the bone trabeculæ, with those (osteoblasts) which lie upon the bone trabeculæ, and with those in the medullary tissue. In a similar manner the intercellular substance of the loose internal periosteal layer (more or less distinct fibrous connective tissue) are continuous with that of the bone trabeculæ, and of the spaces between them. p. 50. (Oc., 3; Obj., 5. Tube half drawn out.)

PLATE XXII.

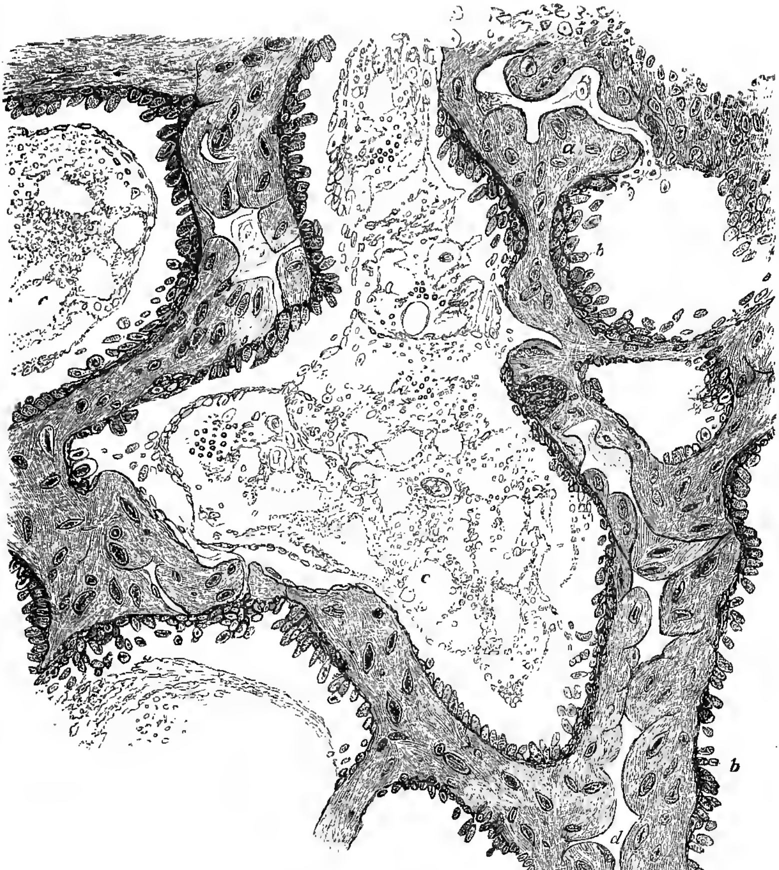


FIG. 61.—Vertical section of the parietal bone of the skull of a child, macerated in chromic acid, showing the bone trabeculæ of the diploe. *a*. Bone trabeculæ, covered by (*b*) osteoblasts. *c*. Medullary tissue (in outline). *d*. Spaces, artificially occasioned by the yielding of the lamellæ of the bone trabeculæ. p. 50. (Low power.)

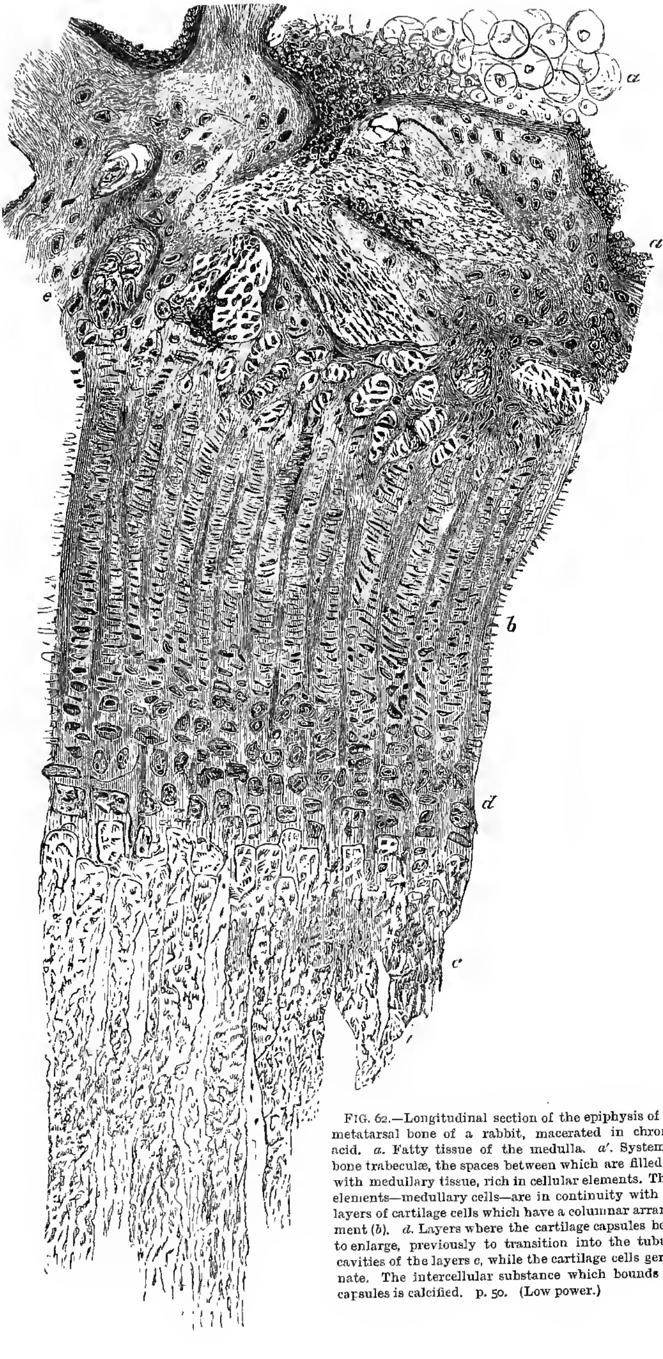
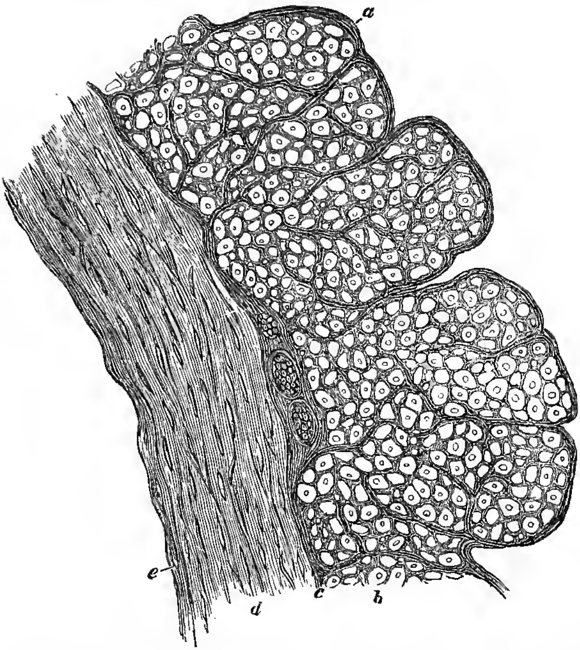


FIG. 62.—Longitudinal section of the epiphysis of the metatarsal bone of a rabbit, macerated in chromic acid. *a*. Fatty tissue of the medulla. *a′*. System of bone trabeculæ, the spaces between which are filled up with medullary tissue, rich in cellular elements. These elements—medullary cells—are in continuity with the layers of cartilage cells which have a columnar arrangement (*b*). *d*. Layers where the cartilage capsules begin to enlarge, previously to transition into the tubular cavities of the layers *c*, while the cartilage cells germinate. The intercellular substance which bounds the capsules is calcified. p. 50. (Low power.)

PLATE XXIV.



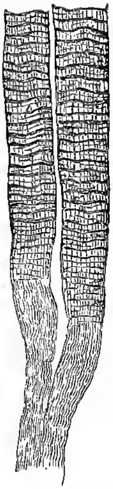


FIG. 63.—Longitudinal section of muscular coat of fallopian tube in a sow. *a.* Connective tissue trabeculæ which form the septa between the bundles of unstriped muscular fibre. *b.* Transverse layer of unstriped muscular fibres, cut across. *c.* Connective tissue which contains the large blood-vessels, and separates the transverse muscular layer *b* from the longitudinal muscular layer *d.* *e.* Outermost, or serous, covering of the fallopian tube. p. 53. (Oc., 3; Obj., 5.)

FIG. 64.—Fresh isolated preparation covered in serum from the tail of a rabbit, showing the transition of transversely striped muscular fibre into a connective tissue bundle, *i.e.*, into tendon. p. 61. (Oc., 2; Obj., 5.)

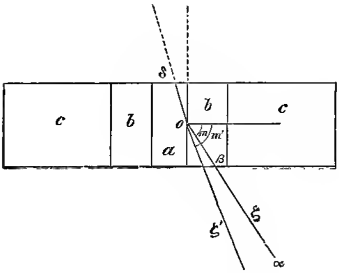


FIG. 15.—Diagram to illustrate the course of a ray of light transmitted through a muscular fibre. (*See* p. 56.)

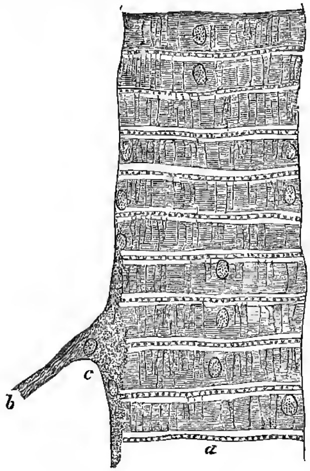
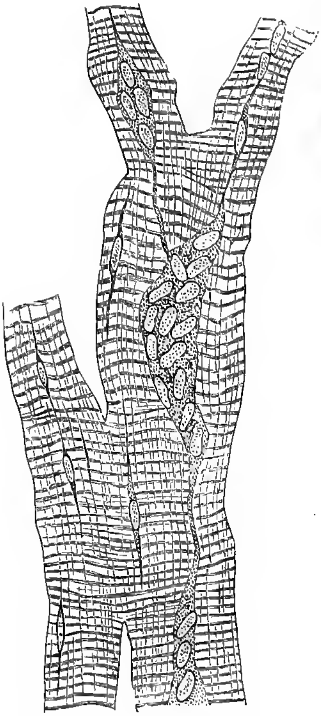


FIG. 65.—Fresh preparation in serum of an isolated muscular fibre of *Hydrophilus piceus* with transverse striæ. *a.* Muscular substance. *b.* Entering non-medullary nerve fibre. *c.* Doyère's prominence. p. 54. (Oc., 3; Obj., 7.)

PLATE XXV.



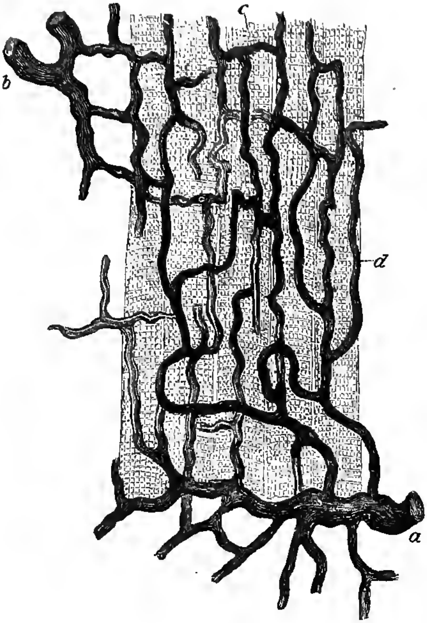


FIG. 66.—Section of an injected muscle of the extremities of a rat, showing the distribution of blood-vessels in the transversely striped muscular tissue. *a.* Arteriole. *b.* Vein. *d.* Capillary between them. *c.* Muscular fibre with transverse striæ. (Oc., 3; Obj., 5.)

FIG. 68.—Isolated muscular fibre with transverse striæ from an oblique section of the tongue of a frog coloured with chloride of gold. The muscle cells are distinctly shown, and three are visible, each containing several nuclei. p. 61. (Oc., 3; Obj., 8.)

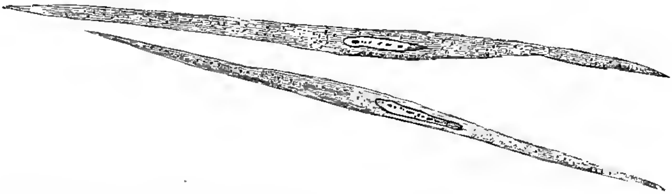


FIG. 67.—Isolated smooth muscular fibres of the small intestine of a cat, macerated in bichromate of potash. The substance of the cells is longitudinally striated, the nuclei are staff-shaped and well defined. p. 52. (Oc., 3; Obj., 7.)

PLATE XXVI.

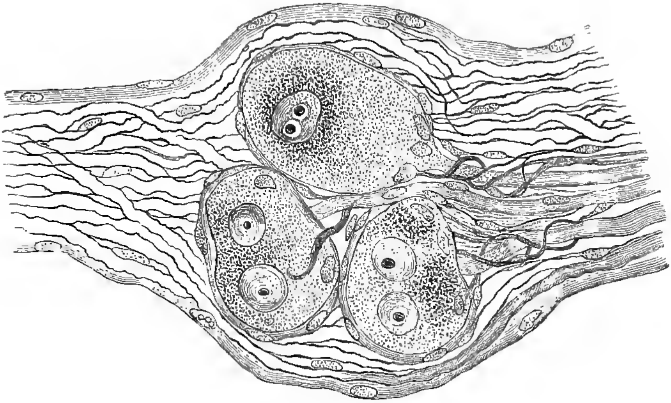


FIG. 70.—Three ganglion cells with spiral fibres in a preparation of the same kind as fig. 69. Each ganglion cell exhibits a nucleated capsule. p. 72. (Oc., 4; Obj., 8.)

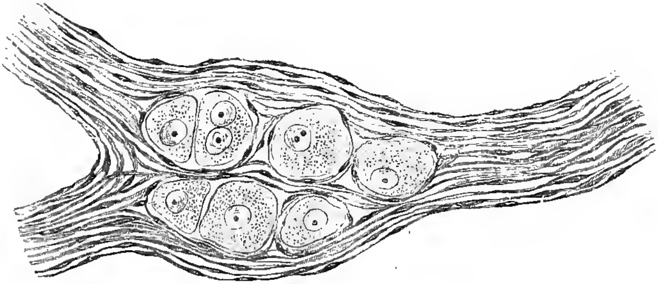
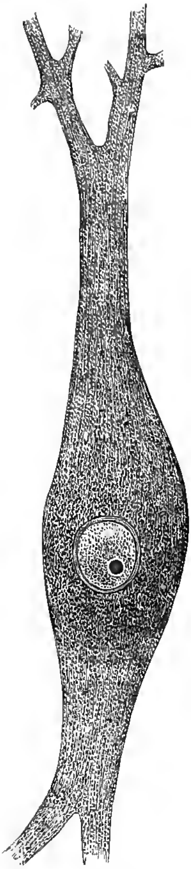


FIG. 69.—Group of ganglion cells of a sympathetic nerve trunk of the urinary bladder of a rabbit. Isolated preparation from a bladder coloured in gold and then treated with dilute acetic acid. p. 72. (Oc., 3; Obj., 7.)

PLATE XXVII.



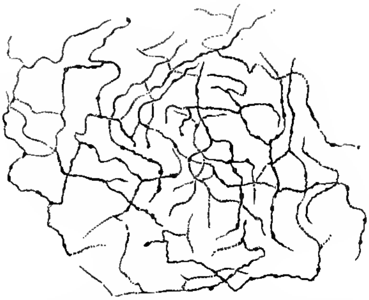


FIG. 73.—Horizontal section of cornea of rabbit coloured with chloride of gold, showing the superficial intra-epithelial network of fine non-medullated nerve fibres, seen from the surface. p. 78. (Magnified 300 diam.)

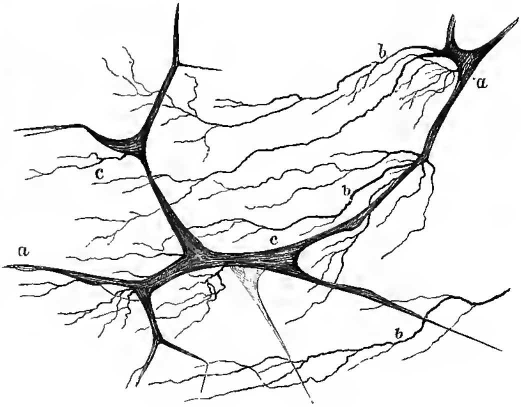


FIG. 71.—Ganglion cell from teased preparation of spinal cord of calf, macerated in bichromate of potash. The ganglion cell may be called bipolar; its distinctly fibrillated structure, and the large nucleus enclosed in a distinct membrane, with its large nucleolus, are specially to be noted. p. 69. (Oc., 3; Obj., 8.)

FIG. 74.—Horizontal preparation of cornea of rabbit coloured in gold, showing a portion of the sub-epithelial nerve-plexus, with *a*, its coarse non-medullated nerve trunks, and *b*, small bundles of non-medullated nerve fibres. p. 78. (Oc., 3; Obj., 7.)

PLATE XXVIII.

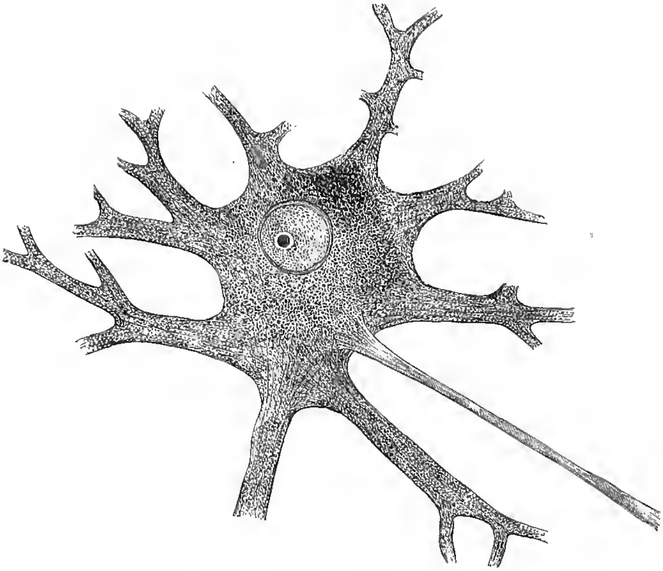


FIG. 72.—A many-branched ganglion cell from the same preparation as fig. 71. All the processes are branched, with the exception of a single pale one—the axis-cylinder process, which is also distinguished from the others by its more delicate longitudinal streaking, and the absence of any granular substance between the stripes. p. 69. (Oc., 3; Obj., 8.)

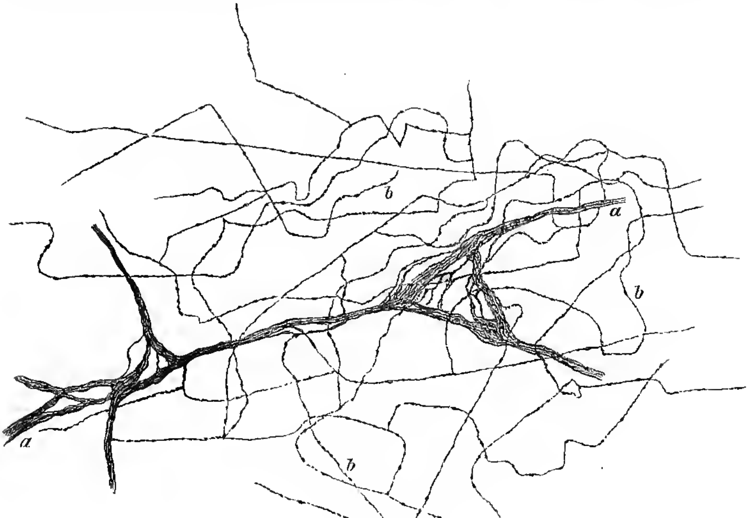


FIG. 75.—Horizontal section of cornea of rabbit coloured in chloride of gold, showing the nerves of the *substantia propria*. *a*. Coarse non-medullated nerve trunk. *b*. Fine non-medullated nerve fibres. p. 78. Magnified 300 diam.)

PLATE XXIX.

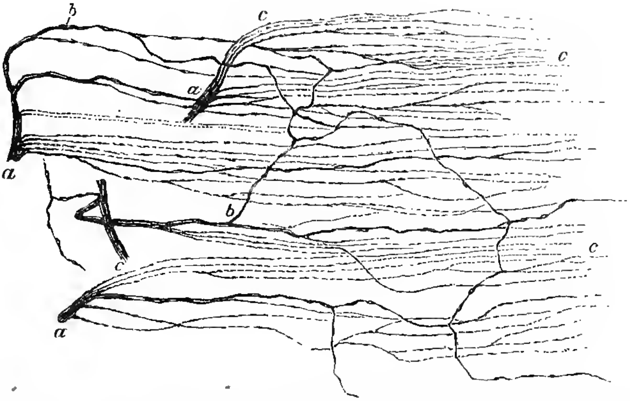


FIG. 76.—Horizontal section of cornea of rabbit coloured in chloride of gold, showing *a*, the coarser non-medullated nerve trunks of the sub-epithelial plexus; *b*, the fine non-medullated nerve fibres; and *c*, tufts of the finest nerve fibrils. p. 78. (Magnified 300 diam.)

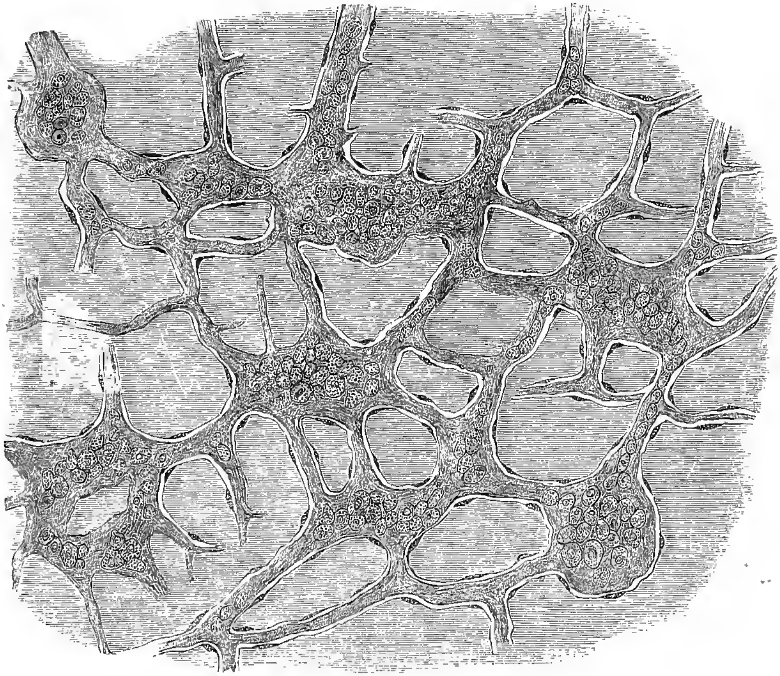


FIG. 77.—Auerbach's plexus of small intestine of human fœtus coloured with gold. The plexus consists of fibrillated substance, and is made up of trabeculæ of various thicknesses, which unite in large placoids. Nucleus-like elements (unformed ganglion cells) and ganglion cells are embedded in the plexus, the whole of which is enclosed in a nucleated sheath. p. 73. (Oc., 2; Obj., 7.)

PLATE XXX.

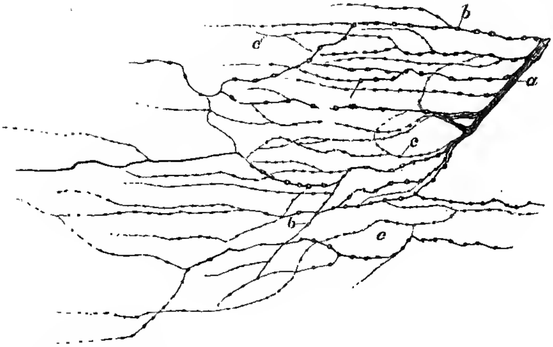


FIG. 79.—Horizontal preparation of cornea of rabbit coloured with chloride of gold. *a*, Larger, *b*, smaller non-medullated nerve fibres; and *c*, the smallest fibrils of the sub-epithelial network. p. 78. (Oc., 3; Obj., 10. Immersion.)

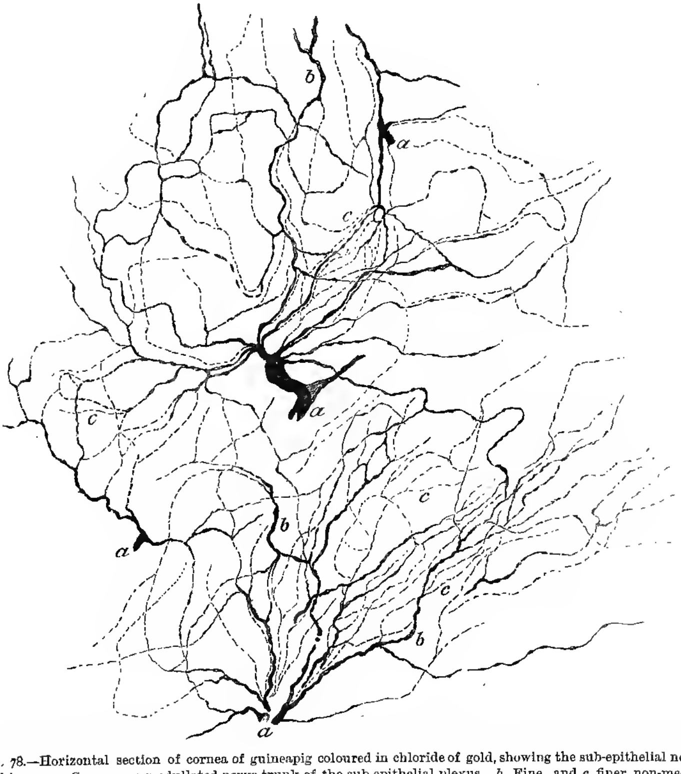


FIG. 78.—Horizontal section of cornea of guineapig coloured in chloride of gold, showing the sub-epithelial nerve branchings. *a*. Coarse non-medullated nerve trunk of the sub-epithelial plexus. *b*. Fine, and *c* finer non-medullated nerve fibres of the sub-epithelial network. p. 78. (Magnified 300 diam.)

PLATE XXXI.

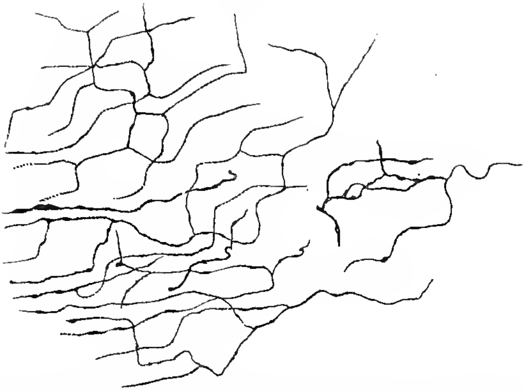


FIG. 80.—Horizontal preparation of cornea of guineapig, showing the superficial intra-epithelial network of non medullated nerve fibres as seen from the surface. p. 78. (Magnified 300 diam.; reduced.)

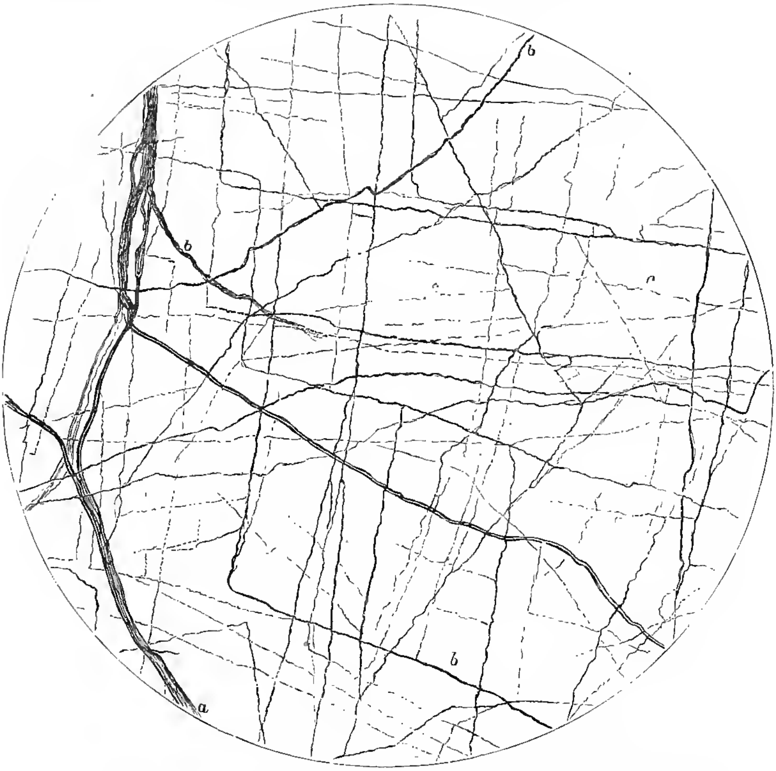


FIG. 81.—Horizontal preparation of cornea of frog coloured with chloride of gold, showing the distribution of non-medullated nerve fibres in a peripheral portion of the cornea. *a*. Coarse non-medullated nerve trunks, nerves of the first order. *b* and *c*, Non-medullated nerve fibres of the second and third order. p. 78. (Oc., 3; Obj., 7.)

PLATE XXXII.

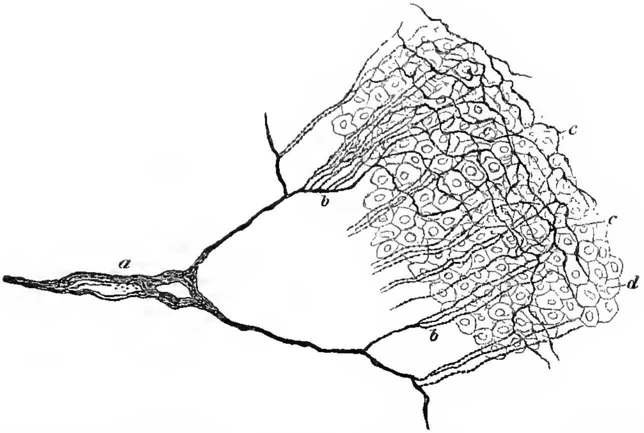


FIG. 83.—Oblique section through the deeper epithelium of the cornea of a rabbit, and the superficial layers of the *substantia propria*. Preparation coloured with chloride of gold. *a*. Coarse non-medullated nerve trunks of the sub-epithelial plexus. *b*. Tufts of fine non-medullated nerve fibres. *c*. Similar fibres of the deep intra-epithelial network. *d*. Epithelial cells. p. 78. (Magnified 300 diam.)

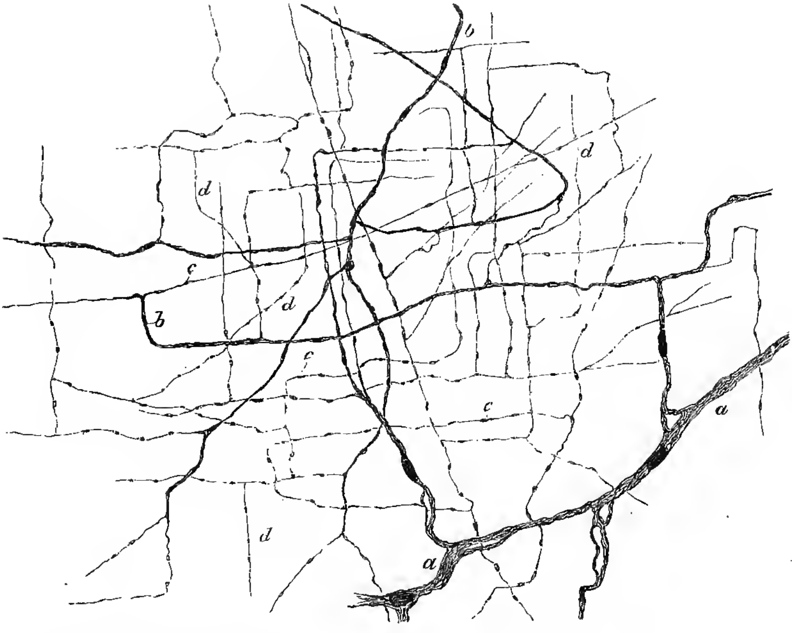
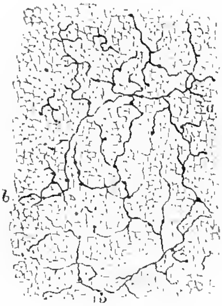


FIG. 82.—Similar preparation to fig. 81, but showing better the nerve fibres of the substance of the cornea. *a*, *b*, and c, as in fig. 81. *d*. Finest non-medullated nerve fibrils. p. 78. (Magnified 300 diam.)

PLATE XXXIII.



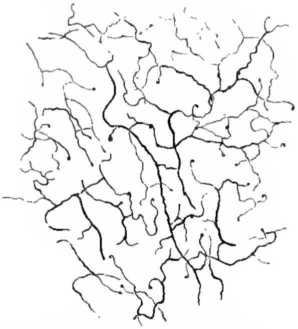


FIG. 84.—Horizontal preparation of the same kind as fig. 83, showing the deep intra-epithelial network of fine non-medullated nerve fibres viewed from the surface. *a*. Contours of deepest cells of anterior epithelium. *b*. Nerve fibres. p. 7 (Oc., 3; Obj., 7. Tube not drawn out.)

FIG. 85.—Horizontal section of cornea of rabbit coloured with chloride of gold, exhibiting more swellings than in fig. 73, which are due either to the mode of preparation or to the appearance of foreshortened nerve fibres passing upwards or downwards into other layers. (Oc., 3; Obj., 7. Tube half drawn out.)

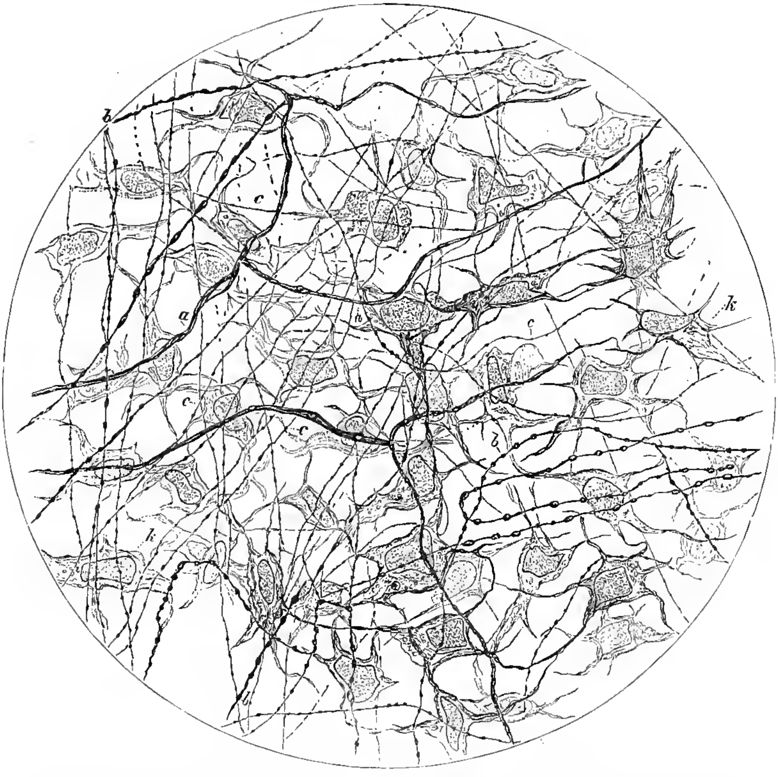


FIG. 86.—Horizontal preparation of cornea of frog coloured in chloride of gold. *a*. Large non-medullated nerve trunks, nerves of the first order. *b*. Nerve fibres of the second order. *c*. Nerve fibres of the third order. *k*. cornea corpuscles. p. 78. (Oc., 3; Obj., 8.)

PLATE XXXIV.

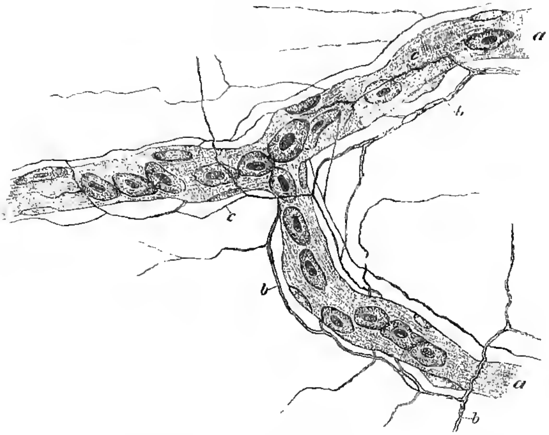


FIG. 87.—Horizontal preparation of nictitating membrane of frog in chloride of gold, showing the distribution of non-medullated nerve fibres to, *a*, capillary blood-vessels. *b*. Coarse non-medullated nerve fibres giving off fine branches *c*, which form a plexus around the vessel. p. 79. (Oc., 3; Obj., 8.)

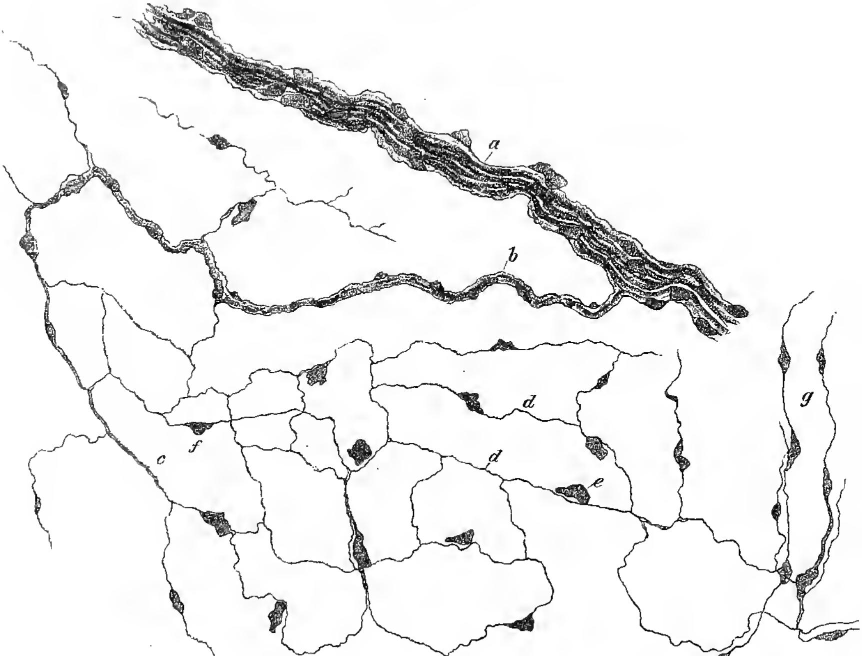


FIG. 88.—Mesentery of frog treated with chloride of gold. *a*. Large trunk of medullated nerve fibres. *b*. A single medullated nerve fibre. *c* and *d*. Non-medullated nerve fibres. *e*. An element belonging to the *membrana propria* of the mesentery. *f*. Nucleus of fine non-medullated nerve fibre. *g*. Capillary blood-vessel. p. 82. (Oc., 3; Obj., 8.)

PLATE XXXV.

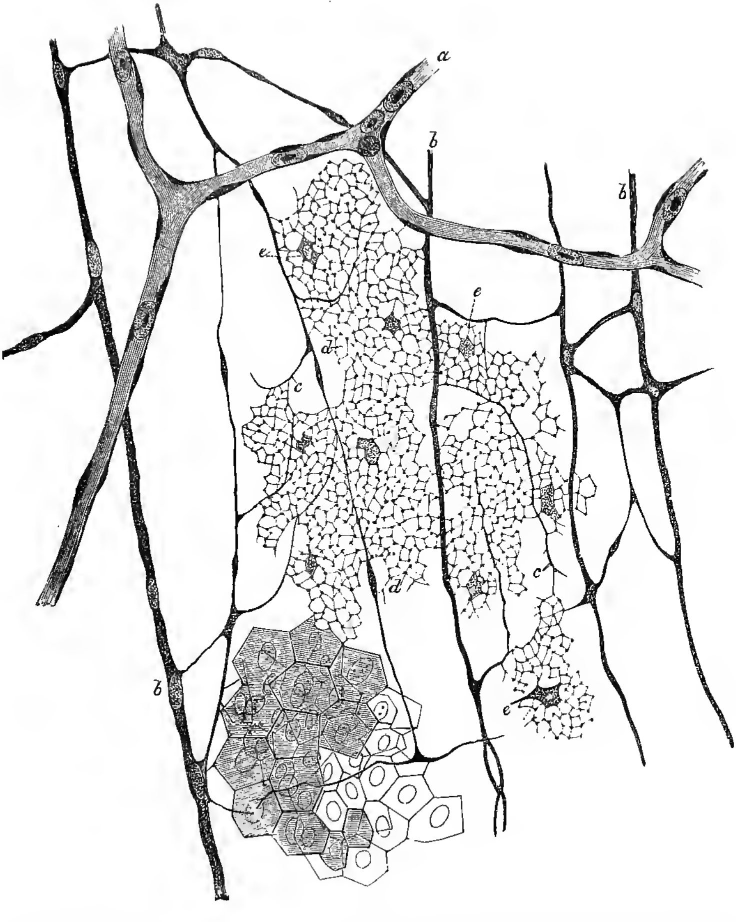


FIG. 89.—Horizontal preparation of the tail of the tadpole treated with chloride of gold. *a*. Capillary blood-vessel. *b*. Coarse non-medullated nerve trunks. *c*. Fine non-medullated nerve fibres. *d*. Minute fibrils of the ultimate sub-epithelial network, in which cells and nuclei, *e*, are scattered. In one part of the preparation the surface epithelium is left, which shows the relative size of the meshes of the sub-epithelial network. p. 80. (Oc., 3; Obj., 7. Tube not drawn out.)

PLATE XXXVI.

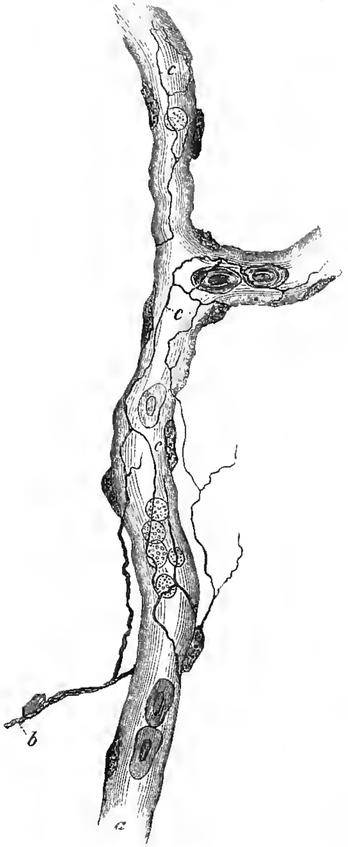


FIG. 90.—Mesentery of frog prepared in chloride of gold, showing the distribution of non-medullated nerve fibres to a capillary blood-vessel, *a*. *b*. A coarse non-medullated nerve fibre giving off finer branches, which form a plexus round the capillary. Some of these finer fibres belong to the wall of the vessel. p. 83. (Oc., 4; Obj., 8.)

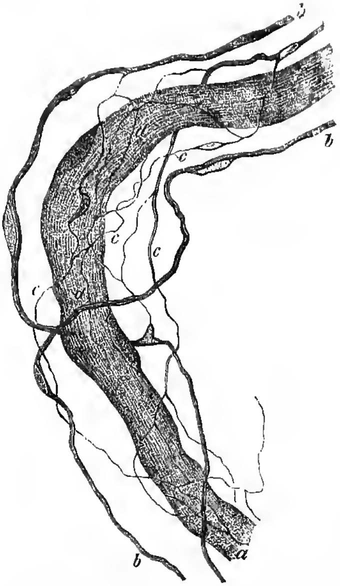


FIG. 91.—Horizontal section of tongue of frog treated with chloride of gold, showing the distribution of non-medullated nerve fibres to a capillary blood-vessel. *a*. Capillary vessel. *b*. Coarse non-medullated nerve fibres. *c* and *d*. Fine non-medullated nerve fibres forming a plexus which surrounds the vessel like a sheath. *d*. Non-medullated nerve fibres in the wall of the vessel p. 83. (Oc., 3; Obj., 8.)

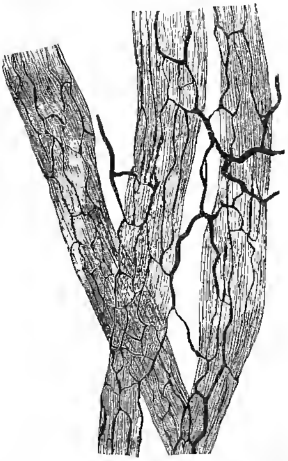


FIG. 92.—Transverse section of mucous membrane of vagina of rabbit prepared with chloride of gold, showing the plexuses of non-medullated nerve fibres which surround the bundles of unstriped muscular fibre. p. 83. (Oc., 3; Obj., 8. Tube not drawn out.)

PLATE XXXVII.

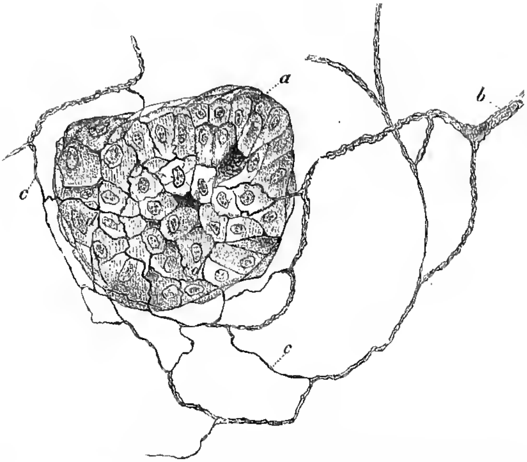


FIG. 93.—Horizontal preparation of the base of a gland of the *membrana nictitans* of the frog stained with chloride of gold, showing the distribution of non-medullated nerve fibres to the gland. *a. Membrana propria* of gland. *b.* Coarse non-medullated nerve trunk. c. Fine non-medullated nerve fibres, which form a plexus round the gland. From these fibres, fine fibrils proceed, which penetrate between the epithelial cells, *d*, of the gland. p. 79. (Oc., 3; Obj., 8.)

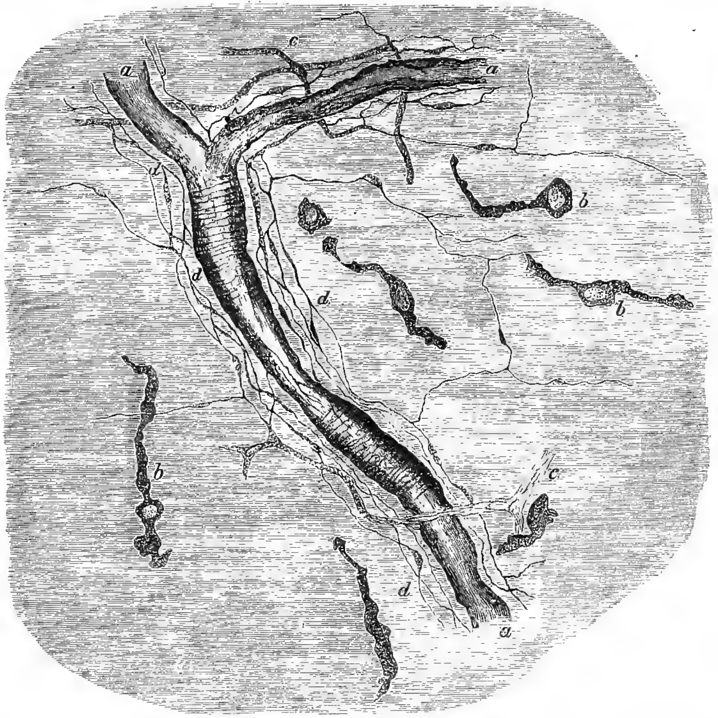


FIG. 9.—Horizontal section of tongue of frog treated with chloride of gold, showing the distribution of non-medullated nerve fibres to an arteriole. *a.* Minute artery giving off two capillaries. Circular muscular fibres are visible in two places on the arteriole. *b.* Connective tissue corpuscles of the intermuscular tissue. *c.* Coarse non-medullated nucleated nerve fibres. *d.* Fine non-medullated nerve fibres forming a plexus like a sheath around the vessel. Many of these contain nuclei. pp. 37 and 83. (Oct., 3; Obj., 7.)

PLATE XXXVIII.

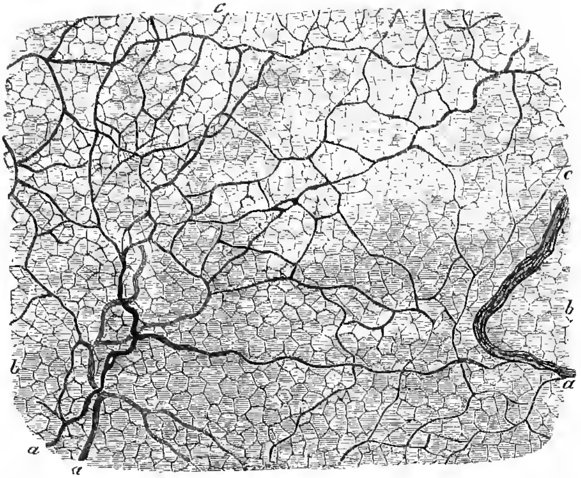
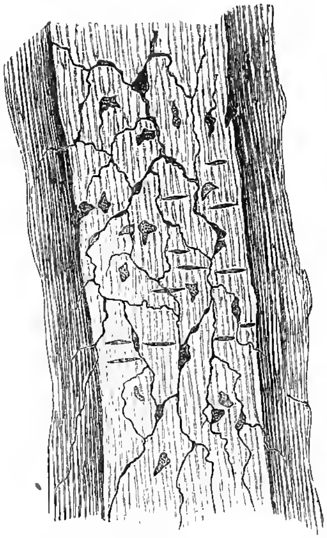


Fig. 94.—Horizontal section of mucous membrane of vagina of rabbit stained with chloride of gold, showing the distribution of the non medullated nerves under the surface epithelium. *a*. Coarse nerve trunks. *b*. Outlines of the deepest epithelial cells. *c*. Non-medullated nerve fibres forming a plexus. In some places branchlets may be seen, which, leaving the network, become identified with the interstitial substance of the deepest epithelial cells. p 83. (Oc., 3; Obj., 8. Tube not drawn out.)



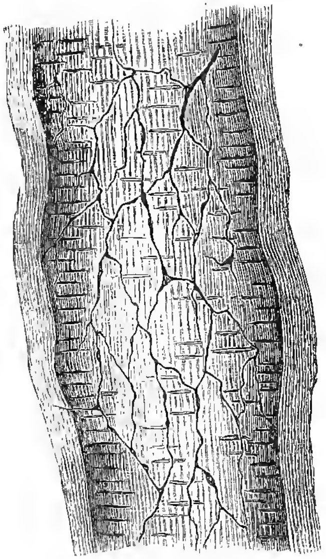


FIG 95.—Horizontal preparation of mesentery of a frog treated with chloride of gold, giving the surface-view of a large vein with the plexus of nucleated non-medullated nerve fibres which lie in the adventitia of the vessel.

FIG. 96.—Same preparation, showing the plexus of similar fibres in the adventitia of a large artery. (Oc., 3 Obj., 7.)

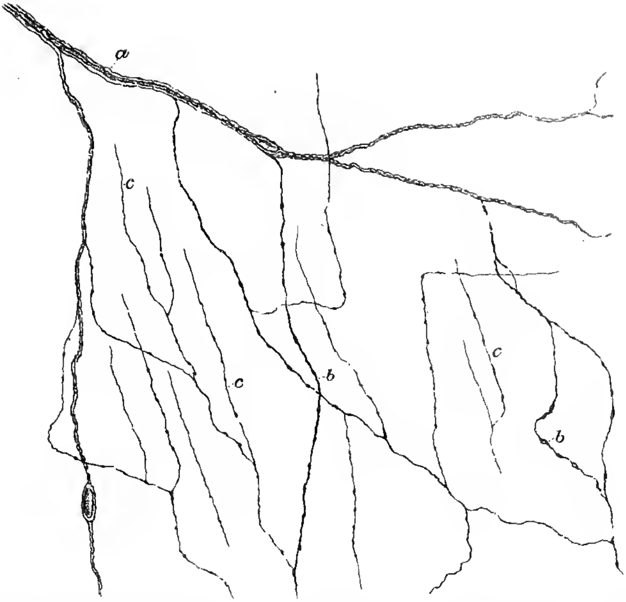


FIG. 97.—Horizontal preparation of nictitating membrane of frog, coloured in chloride of gold, showing the distribution of the non-medullated nerve fibres under the epithelium of the posterior surface. *a*. Larger, *b* smaller *c* smallest non-medullated nerve fibres. p. 79. (Oc., 3; Obj., 8.)

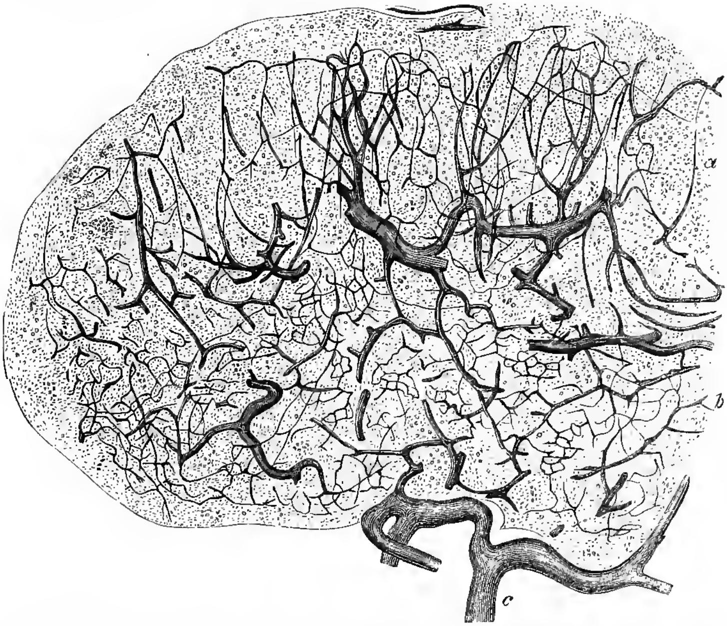


FIG. 98.—Vertical section of injected mesenteric gland of guineapig, showing the distribution of the blood-vessels. *a*. Cortical layer. *b*. Medullary layer. *c*. Large blood-vessels of the hilus of the gland. p. 118. (Oc., 3; Obj., 2.)

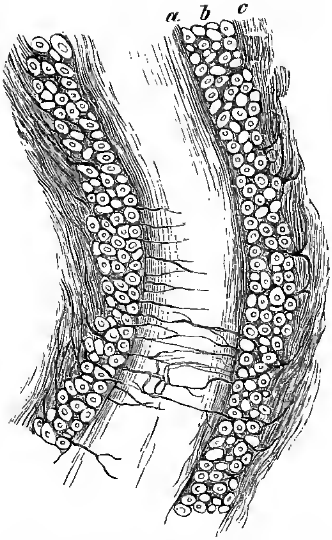


FIG. 99.—Longitudinal section of a branch of the pulmonary artery, from the lung of a guineapig, the bronchiæ of which were injected with dilute chromic acid. *a*. Intima. *b*. Circular layer of unstriped muscular fibres, cut across. *c*. Adventitia. p. 106. (Oc., 3; Obj., 7.)

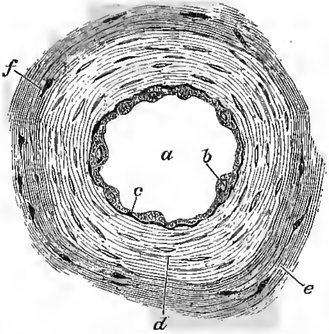


FIG. 100.—Transverse section of an artery from a vertical section of the skin of a guineapig, coloured with gold. *a*. Lumen of the vessel. *b*. Endothelium seen in profile. *c*. Intima. *d*. Circular muscles, *e*. Adventitia. *f*. Cellular elements of adventitia. p. 106. (Oc., 3; Obj., 7.)

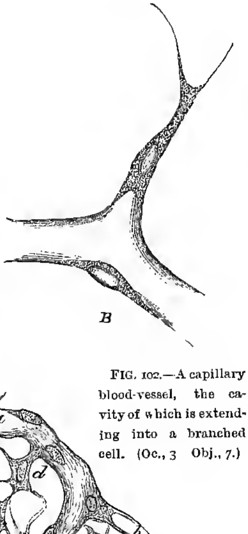


FIG. 102.—A capillary blood-vessel, the cavity of which is extending into a branched cell. (Oc., 3 Obj., 7.)

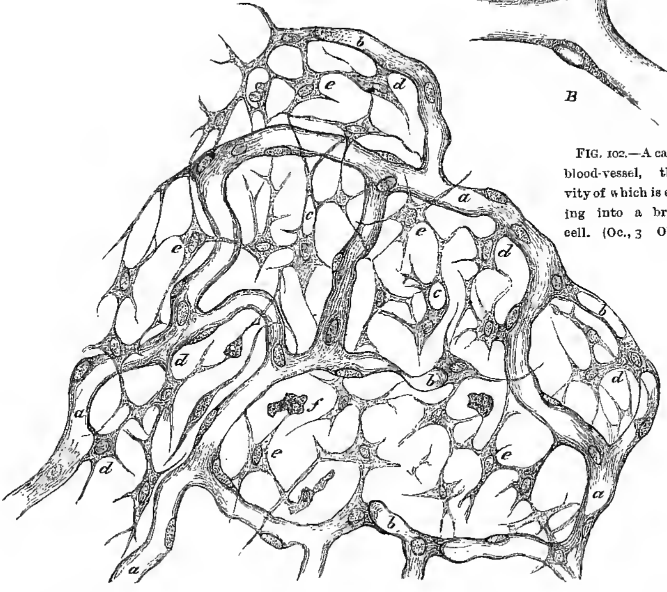


Fig. 101.—Preparation from the normal omentum of a rabbit, first pencilled and then treated with silver, showing the development of young capillaries. *a*. Capillary blood-vessels. *b*. Capillaries only just hollowed out; this process of excavation is taking place in the branched connective tissue cells, *d*, which are in relation with the capillary wall. *c*. Vacuoles in the branched cells. *e*. Branched cells of the ground-substance. *f*. Migratory cells. (Oc., 3 Obj., 7.)

PLATE XLI.

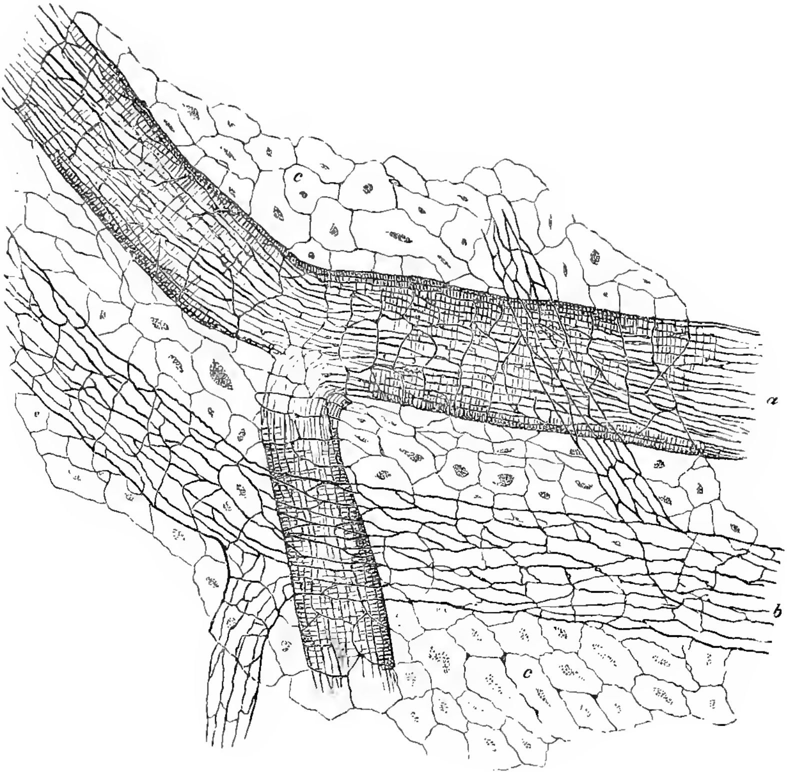


FIG. 103.—Omentum of rabbit coloured in silver. *a.* One of the larger arteries, showing the spindle-shaped endothelium and transverse muscular fibre. *b.* One of the larger veins, showing the endothelial elements, which are not so elongated as in the artery. *c.* Endothelium of one of the surfaces of the membrane. p. 105. (Oc., 3 Obj., 5.)

Plate XLII.

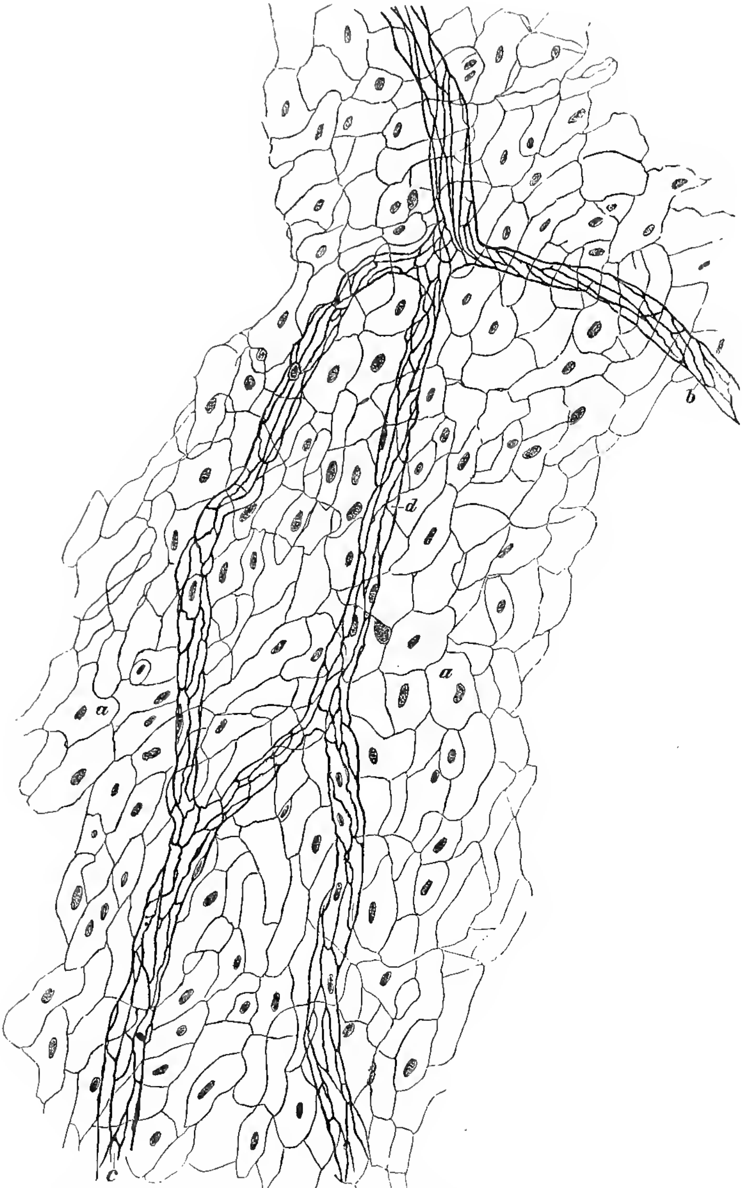


FIG. 104.—Part of the same preparation as fig. 103. *a.* Endothelium of one of the surfaces. *b.* An arteriole branching into true capillaries *d*, which are continued into a capillary vein *c*. The endothelium is clearly shown in all the vessels. (Oc., 3; Obj., 7.)

PLATE XLIII.

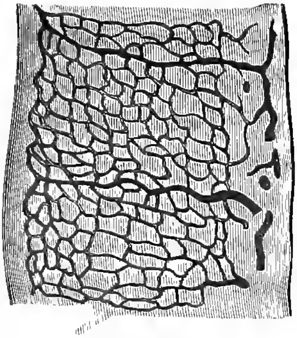


FIG. 105.—Vertical section of mucosa and submucosa of injected stomach of a rat, showing the rich capillary system of the mucosa which contains the peptic glands. p. 126. (Oc., 3; Obj., 2.)

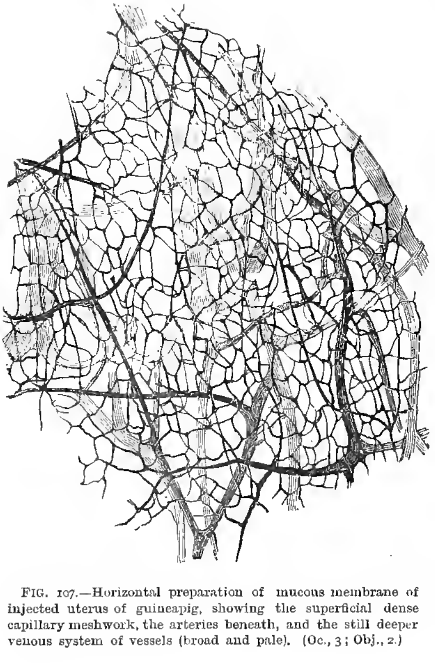


FIG. 107.—Horizontal preparation of mucous membrane of injected uterus of guineapig, showing the superficial dense capillary meshwork, the arteries beneath, and the still deeper venous system of vessels (broad and pale). (Oc., 3; Obj., 2.)

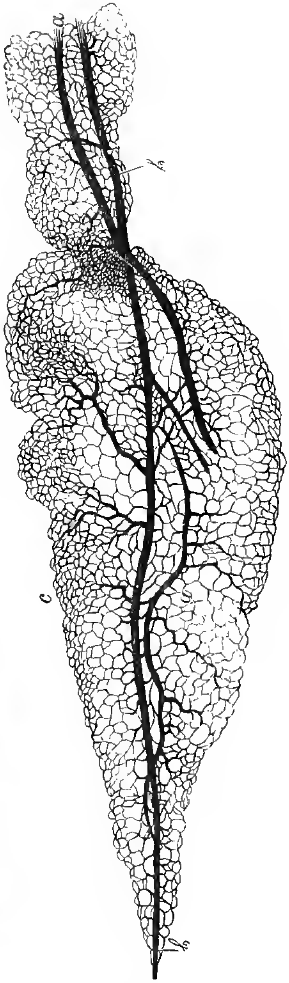


FIG. 106.—A fat tract from the omentum of an injected guineapig. *a*. Artery. *b*. Vein. *c*. Dense system of capillary vessels of true fatty tissue. (Oc., 2; Obj., 2.)

Plate XLIV.

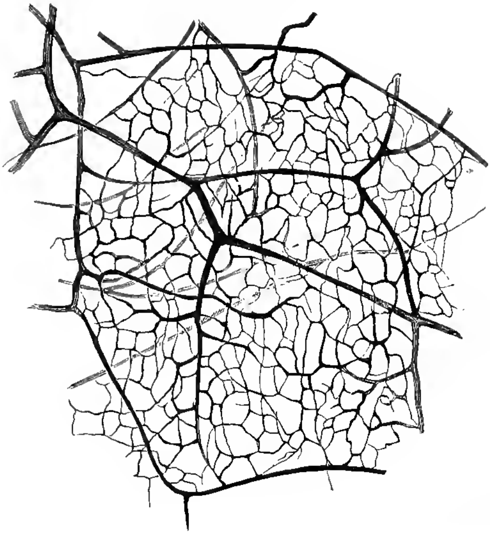


FIG. 108.—Surface preparation of the mucous membrane of the stomach of a rat, injected; showing the superficial arteries, the dense network of capillaries, and the deep veins, which are pale. (Oc., 3; Obj., 2.)

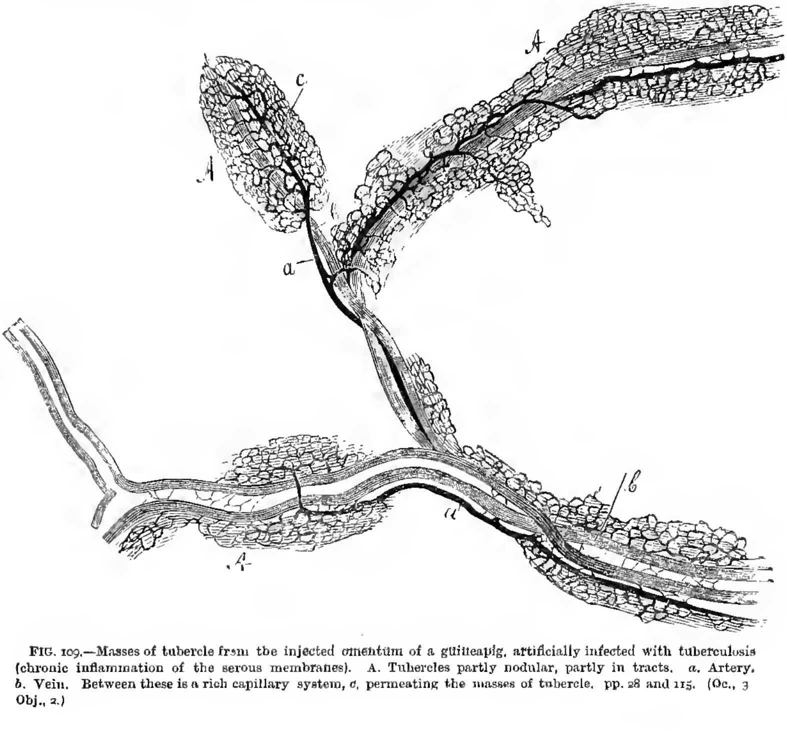


FIG. 109.—Masses of tubercle from the injected omentum of a guineapig, artificially infected with tuberculosis (chronic inflammation of the serous membranes). A. Tubercles partly nodular, partly in tracts. *a*, Artery. *b*. Vein. Between these is a rich capillary system, *c*, permeating the masses of tubercle. pp. 28 and 115. (Oc., 3 Obj., 2.)

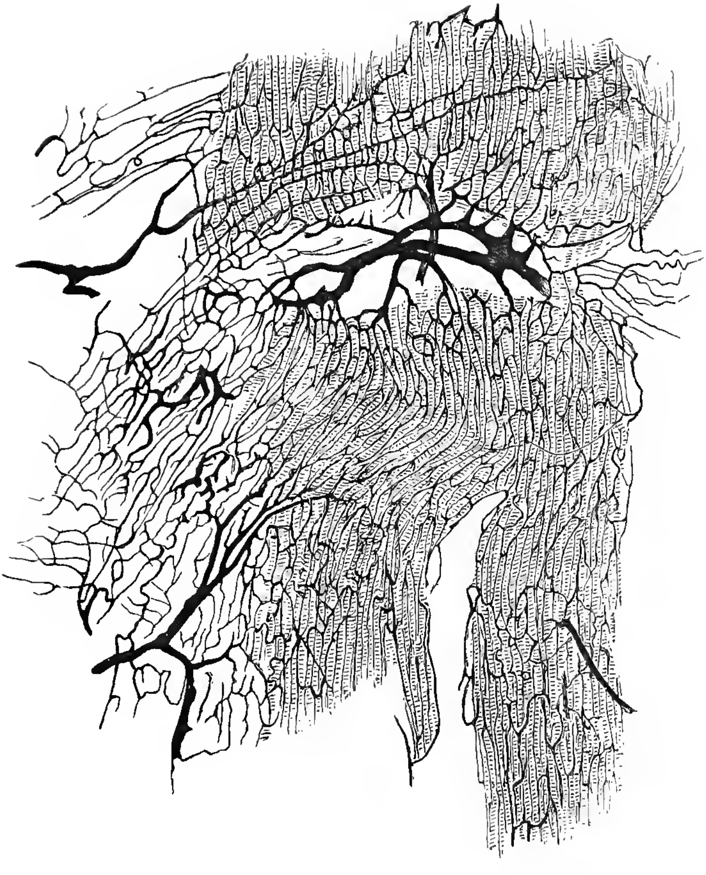


FIG. 110.—Vertical section of injected tongue of rabbit, showing the rich system of vessels with which the transversely striped muscular substance is provided. (Oc., 3; Obj., 2.)

PLATE XLVI.

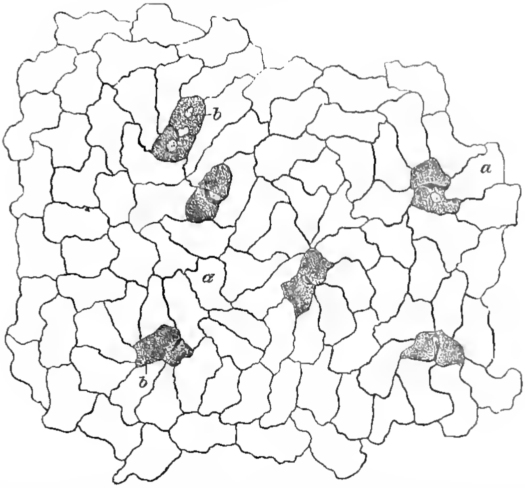


FIG. 111.—Mesentery of frog coloured in silver. *a*. Ordinary surface endothelium. *b*. Endothelial cells surrounding a simple true stoma. These cells have the germinating character, are distinctly granular, and are not flat like those which surround them. p. 112. (Oc., 3; Obj., 5. Tube not drawn out.)

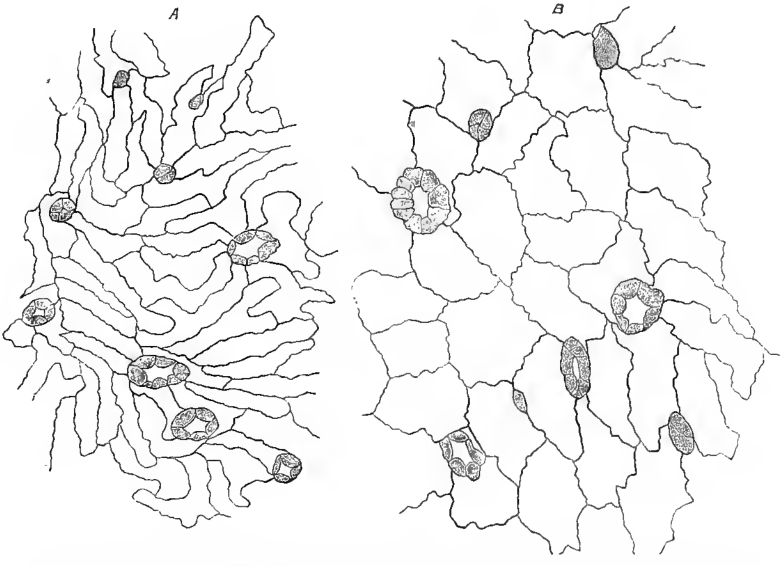


FIG. 112.—*Septum cisternæ lymphaticæ magnæ* of frog, coloured in silver. A. View of peritoneal surface. B. View of surface of lymph sac. The stomata, some of which are open, some collapsed, are surrounded by germinating endothelium, which is ciliated if the subject is a female. p. 112. (Oc., 3; Obj., 5.)

PLATE XLVII.

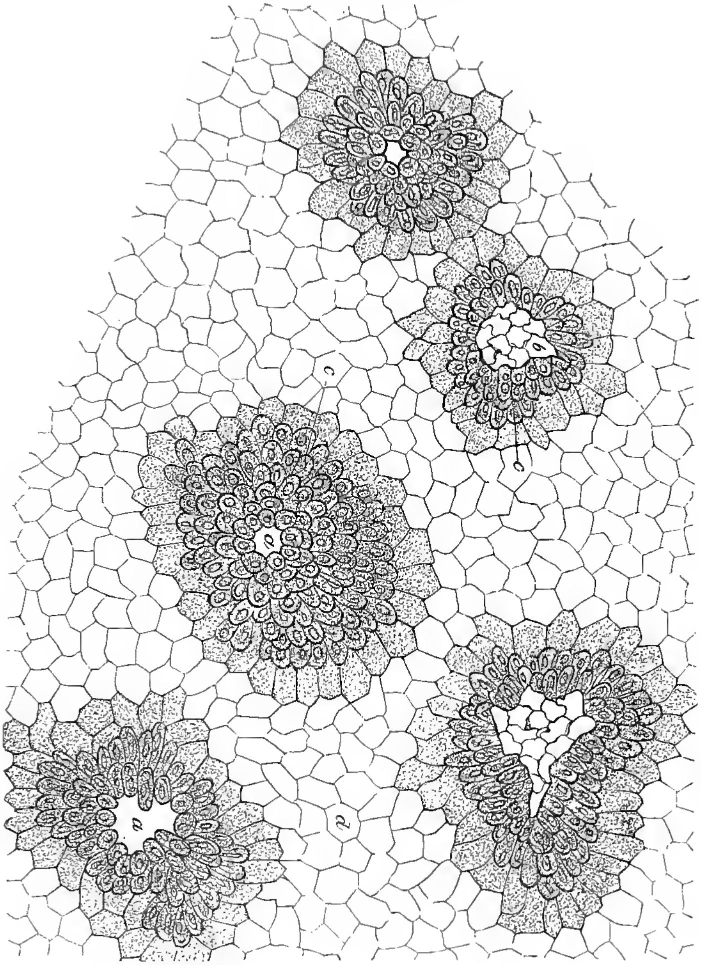


Fig. 113.—Surface view of mesentery, coloured in silver, of a guineapig affected with chronic inflammation of the serous membranes from artificially induced tuberculosis. Proliferation of the surface endothelium which surrounds a true stoma is seen; *i.e.*, germinating endothelium. *a.* True stoma, open. *b.* Simple lymph lacunæ, the endothelium of which is exposed because the stomata belonging to them are wide open. *c.* Proliferating endothelium. *d.* Ordinary surface endothelium, p. 112. (Oc., 3; Obj., 5.)

PLATE XLVIII.

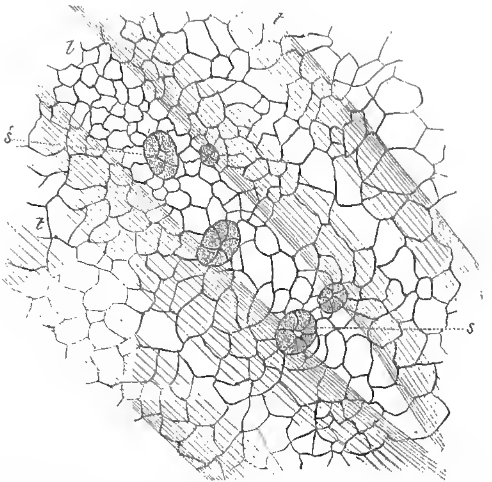


FIG. 115.—Peritoneal surface of centrum tendineum of rabbit, treated with water and then coloured in silver. In the middle of the preparation a lymph vessel, *l*, appears below the surface endothelium, *i.e.*, the system of lines of interstitial substance. On both sides of the lymph vessel are tendon trabeculæ, *t*. The endothelium which covers the lymph channels consists of smaller elements. Five true stomata are shown which pass through the "vertical lymph channels" into the lymph vessel below. Two of the stomata are open, and three collapsed; all are surrounded by germinating endothelium. p. 111. (Oc., 3; Obj., 5. Tube not drawn out.)

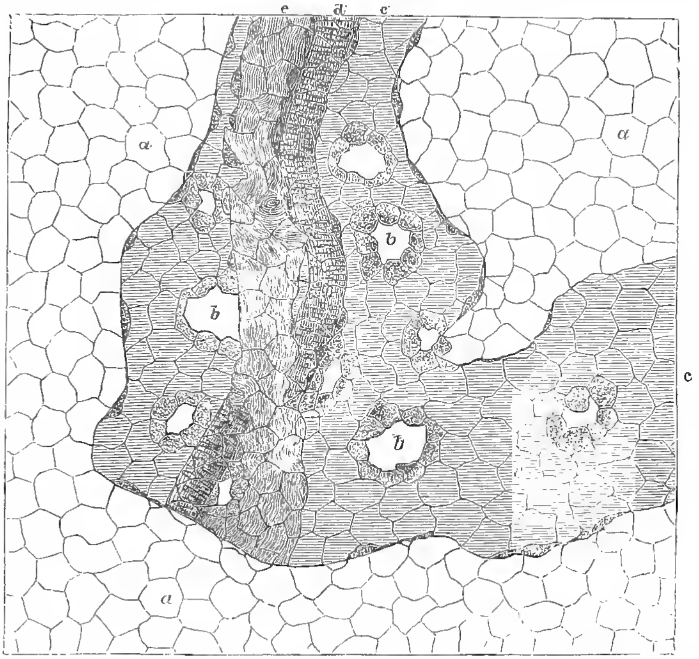


FIG. 114.—Similar preparation. *c*. A wide lymph vessel which can be seen through the surface endothelium *a*. An artery, *d*, and a nerve trunk, *e*, pass through the lymph vessel (perivascular lymph vessel) *c*, and within the field of vision are ten distinctly open true stomata *b*. The surface endothelium bordering the stomata is germinating, p. 112, (Oc., 3, Obj., 5.)

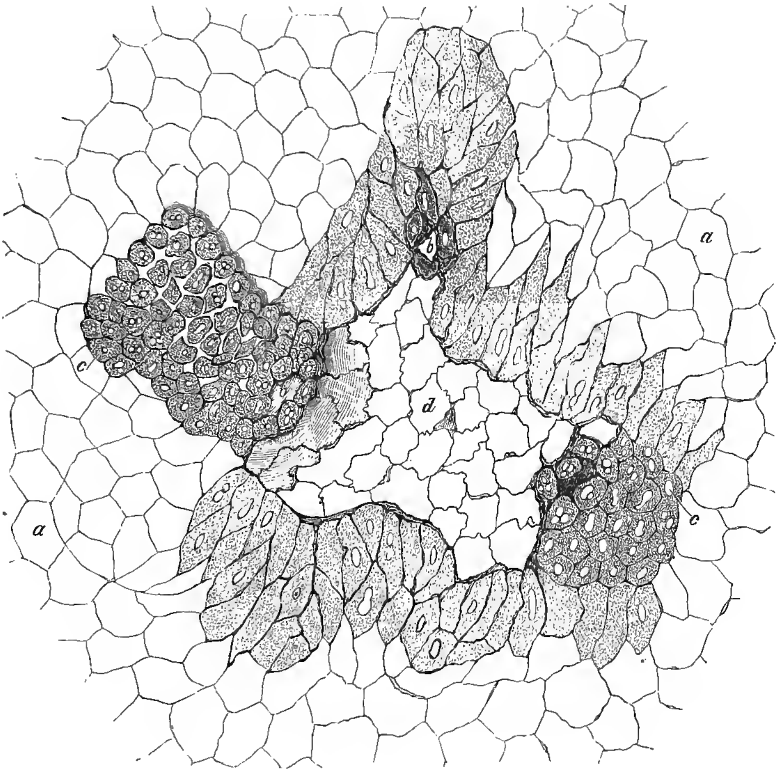


FIG. 116.—Mesentery, coloured in silver, of guineapig affected in the same manner as in fig. 113. *a*. Surface endothelium. *d*. The freely exposed upper wall of a lymph sinus, the endothelial marking of which is seen. On the periphery, however, answering to the free surface of the serous membrane, two distinctly open true stomata, *b*, are shown. These communicate in an oblique direction with the lymph sinus. On the right a closed stoma can be seen. The endothelium, *c*, which borders the stomata is in germination. (Oc., 3; Obj., 7.)

PLATE L.

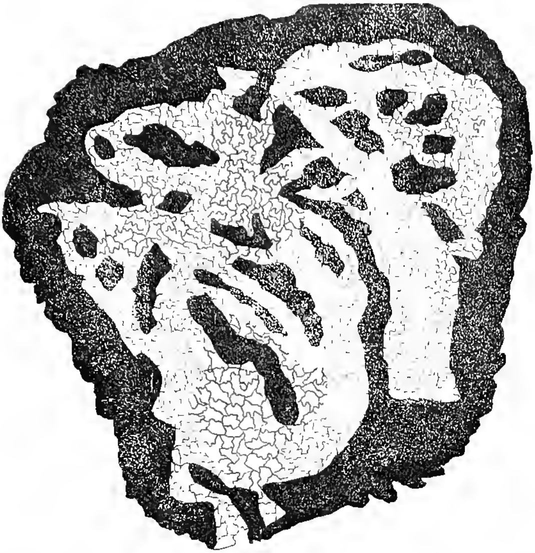


FIG. 117.—Peritoneal surface of centrum tendineum of rabbit, pencilled and coloured in silver, showing the lymph capillaries of the abdominal serous covering in the neighbourhood of the large blood-vessels which pass through the diaphragm. The sinuous endothelium of the lymph capillaries is distinctly shown. p. 114. Oc., 3; Obj., 4. Tube half drawn out.)

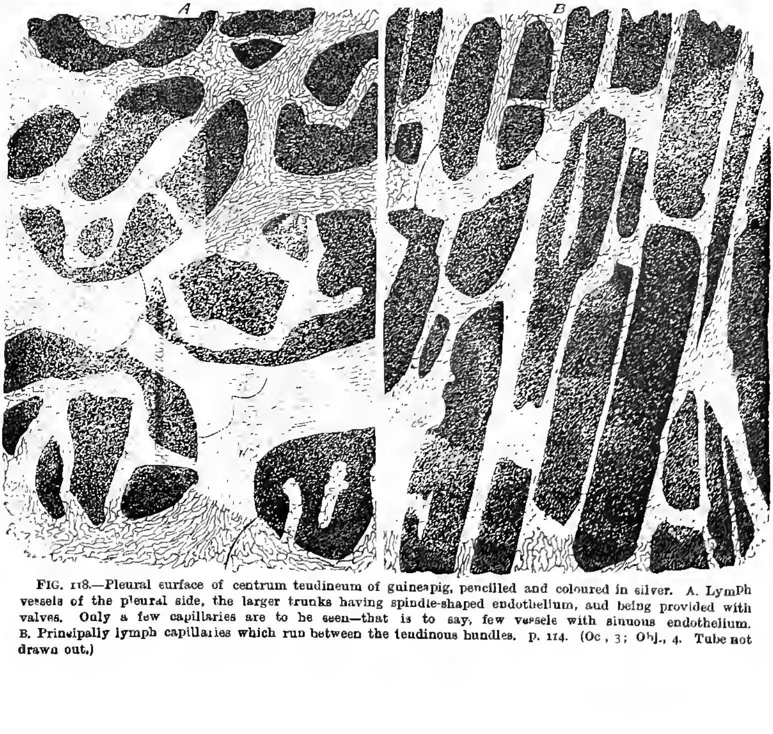


FIG. 118.—Pleural surface of centrum tendineum of guineapig, pencilled and coloured in silver. A. Lymph vessels of the pleural side, the larger trunks having spindle-shaped endothelium, and being provided with valves. Only a few capillaries are to be seen—that is to say, few vessels with sinuous endothelium. B. Principally lymph capillaries which run between the tendinous bundles. p. 114. (Oc , 3; Obj., 4. Tube not drawn out.)

PLATE LI.

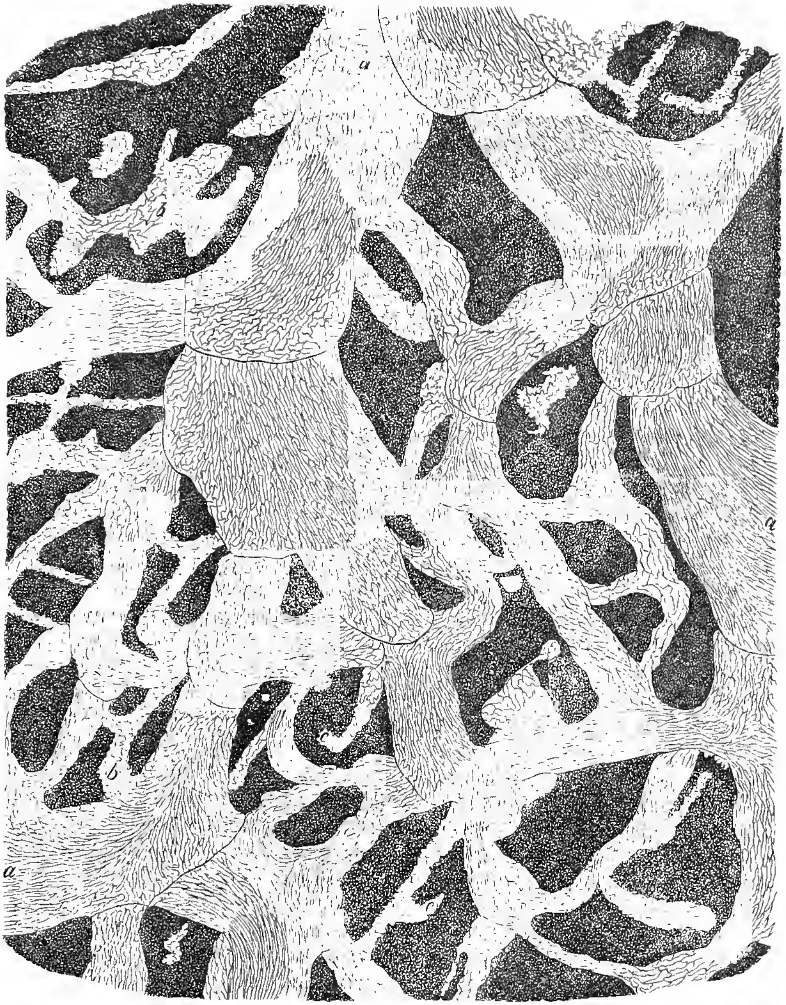


FIG. 119.—Similar preparation of a rabbit. Rich network of lymph vessels of the pleural side. *a.* Large trunks of lymph vessels, having spindle-shaped endothelium and provided with valves. *b.* Lymph capillaries. *c.* Lymph capillaries which penetrate deeply, *i.e.*, which bend towards the abdominal side in order to run between the bundles of tendon. p. 114. (Oc., 3; Obj., 2.)

PLATE LII.

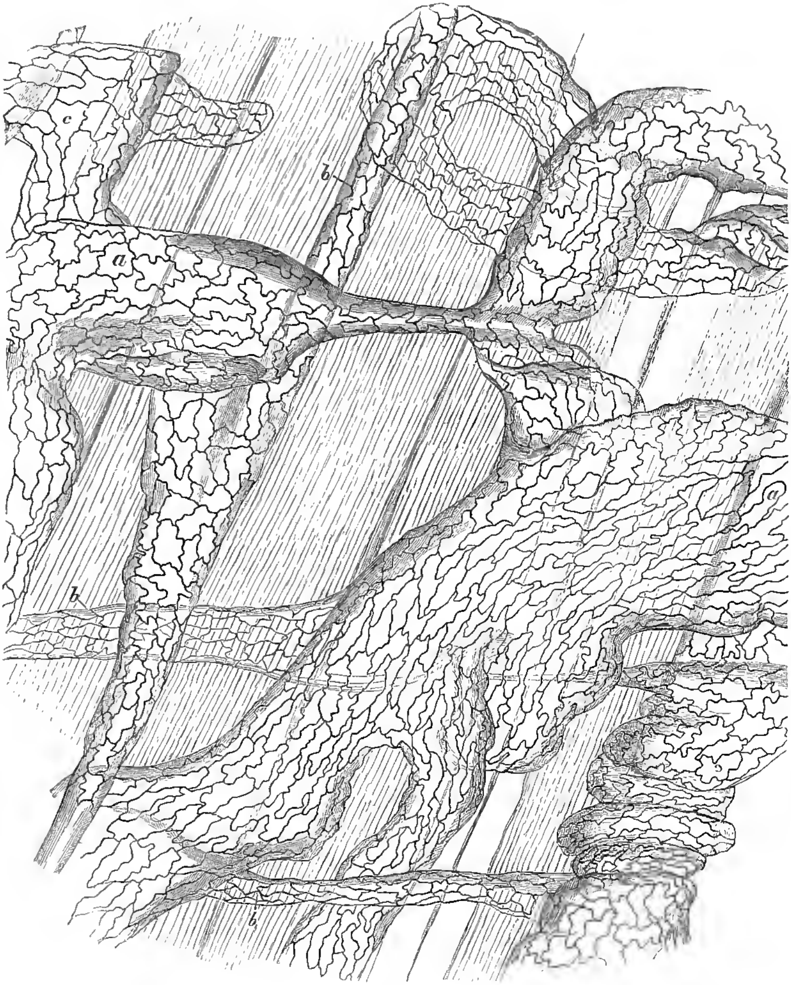


FIG. 120.—Lymphatics of centrum tendineum of rabbit, pencilled under water and then bathed in silver, while artificial respiration was being carried on. The lymph vessels are visible in the slightly-coloured ground as distinct and very sinuous tubes, the endothelium of which is sharply defined. *a*. Trunks of lymph vessels of pleural side. *b*. Lymph capillaries which, as "straight interfascicular lymph capillaries," run between the tendon bundles, and reach to the abdominal side. p. 114. (Oc., 3; Obj., 5.)

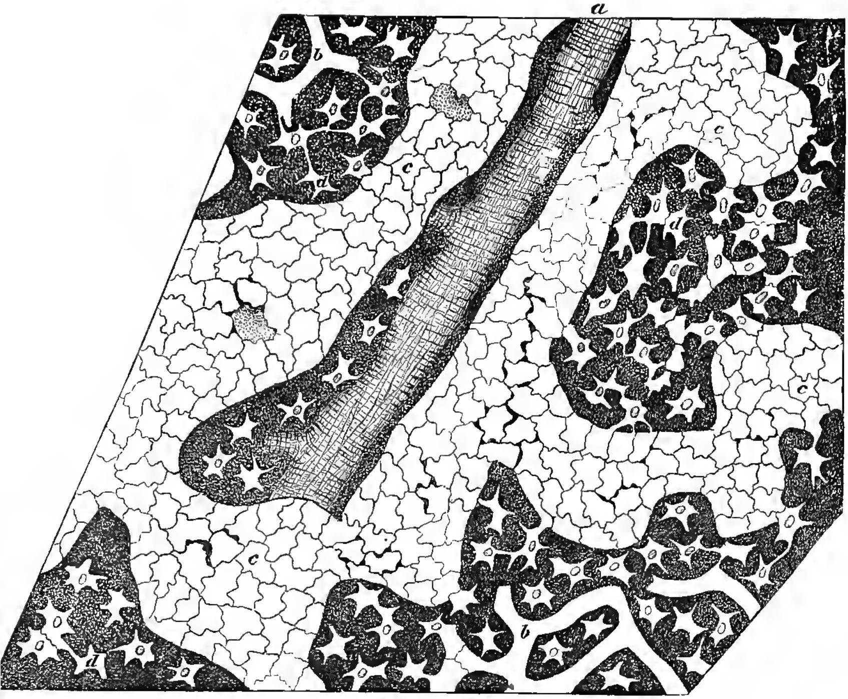


FIG. 121.—Omentum of rabbit, pencilled and coloured in silver. *a.* Artery. *b.* Capillary blood-vessel. *c.* Network of lymphatics, recognized as lymph capillaries by their sinuous endothelium and the absence of valves. *d.* Lymphatic canaliculi of the ground substance; in most of them the nuclei of the cells contained in them are seen. p. 115. (Oc., 3; Obj., 5. Tube half drawn out.)

PLATE LIV.

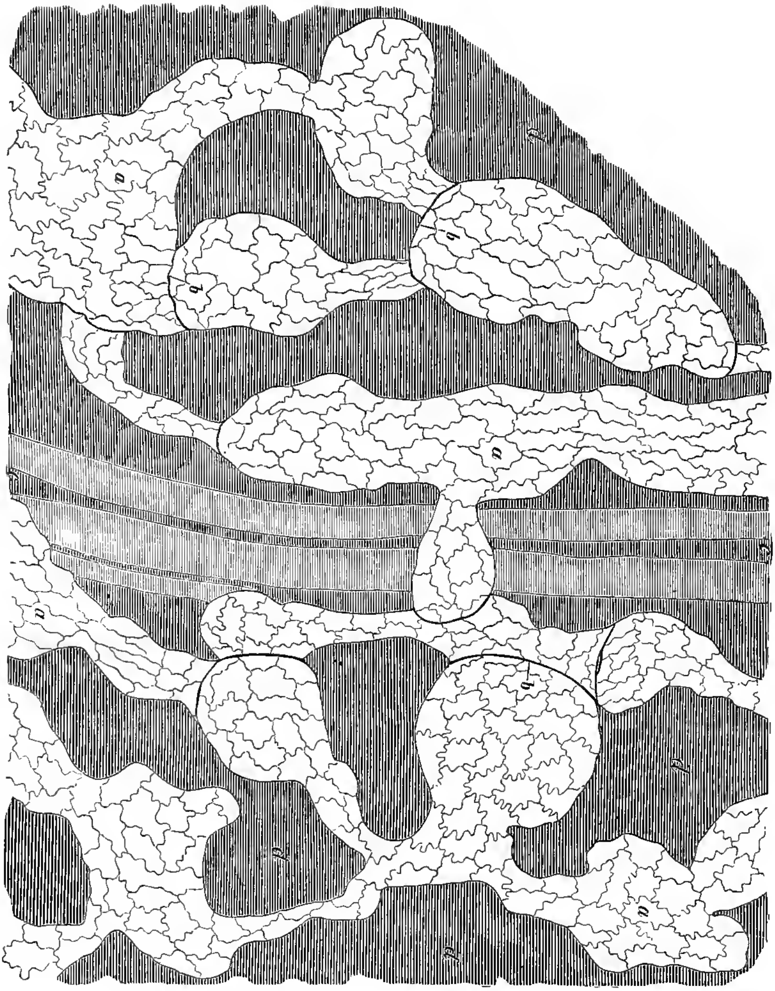


FIG. 122.—Surface of omentum of rabbit, pencilled and coloured in silver, showing the distribution of the lymph vessels. *a*. Lymph vessels, showing their endothelium. *b*. Valves. *c*. Indicates the position of vessels enclosed in a tract, the details of which, as well as those of the ground-substance *d*, are omitted. p. 115. (Oc., 3; Obj., 5.)

PLATE LV.

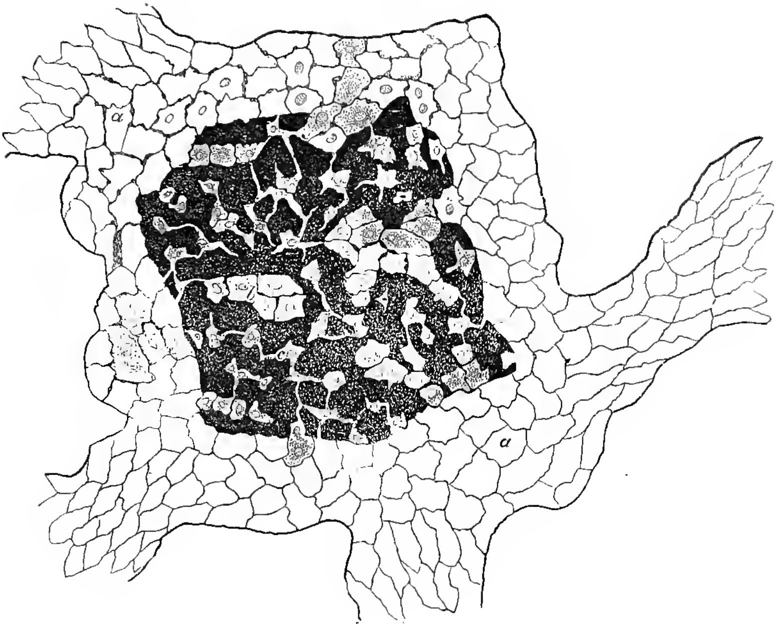


FIG. 123.—Pleural side of pencilled centrum tendineum of a guineapig, in which there was chronic inflammation of the serous membranes, in consequence of artificially induced tuberculosis. *a*. Lymph capillaries of the pleural serosa surrounding an island of ground-substance. In the latter is the canalicular system, with the nucleated flat cells, *b*, which it contains. These cells, in various places, are seen to be dividing; and most of them are branched, *c*. The endothelium of the lymph capillaries is distinctly seen in several places to be in continuity with the cells of the canalicular system. (Oc., 3; Obj., 7. Tube not drawn out.)

PLATE LVI.

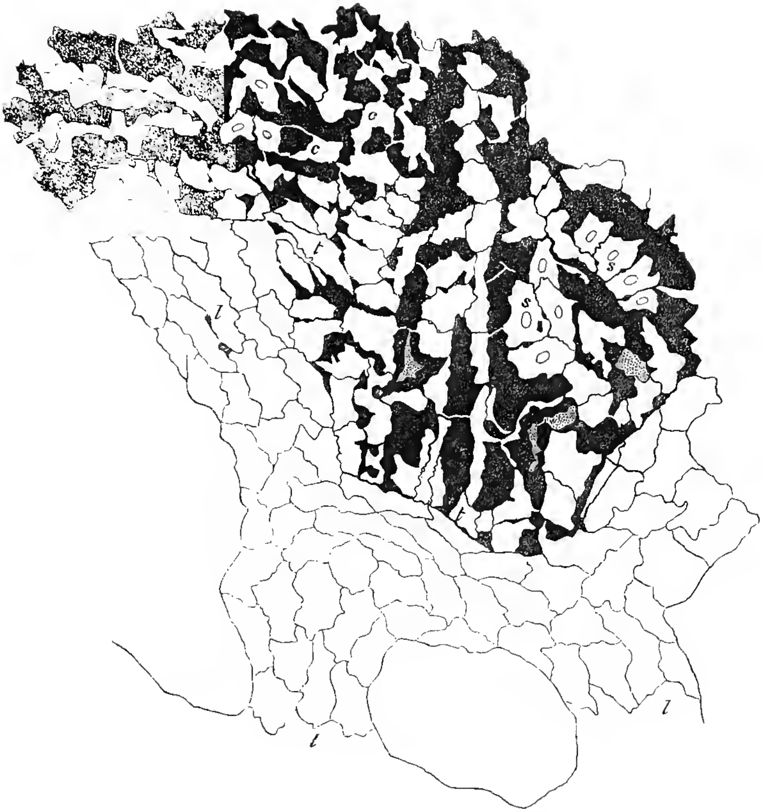


FIG. 124.—Pleural side of centrum tendineum of rabbit, pencilled and coloured in silver. *l*. Lymph capillaries, showing their endothelium. The system of lymphatic canaliculi, *c*, stands out sharply from the dark coloured ground-substance of the pleural serosa; in many places the lacunæ of the canalicular system are separated from each other by mere lines, and a trace of nucleus *s* is to be seen; the placoid cell to which the nucleus belongs is not visible. At *t*, the canalicular system is passing over into endothelium of the lymph capillaries. p. 114. (Oc., 3; Obj., 7. Tube half drawn out.)

PLATE LVII.

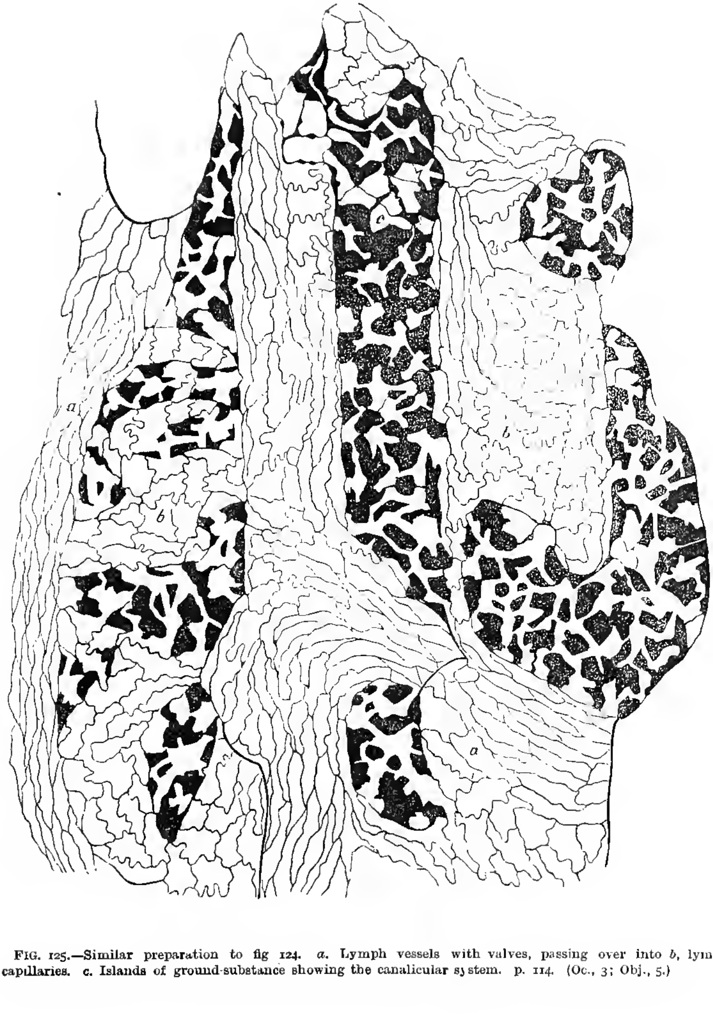


FIG. 125.—Similar preparation to fig 124. *a*, Lymph vessels with valves, passing over into *b*, lymph capillaries. *c*. Islands of ground-substance showing the canalicular system. p. 114. (Oc., 3; Obj., 5.)

PLATE LVIII.

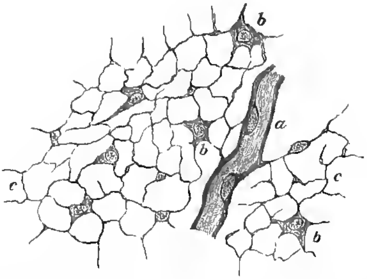


FIG. 127.—Section of cortical layer of mesenteric gland of ox, which has been hardened in Müller's liquid and then shaken. *a*. Capillary blood-vessel. *b*. Nucleated cells representing the nodes of the delicate reticulum —adenoid tissue. (Oc., 3; Obj., 7.)

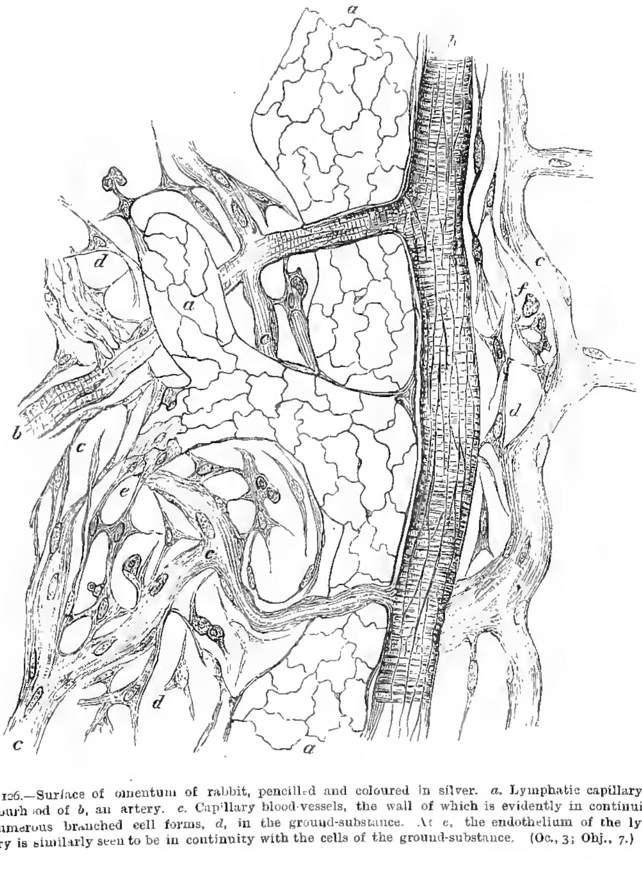


FIG. 126.—Surface of omentum of rabbit, pencilled and coloured in silver. *a*. Lymphatic capillary in the neighbourhood of *b*, an artery. *c*. Capillary blood-vessels, the wall of which is evidently in continuity with the numerous branched cell forms, *d*, in the ground-substance. At *e*, the endothelium of the lymphatic capillary is similarly seen to be in continuity with the cells of the ground-substance. (Oc., 3; Obj., 7.)

PLATE LIX.

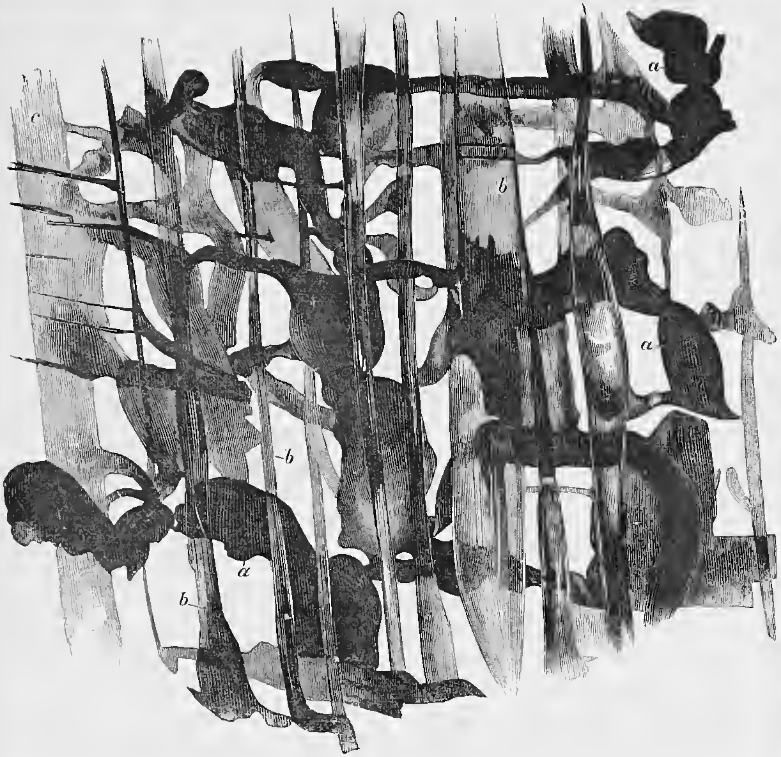


FIG. 128.—Centrum tendineum of rabbit, seen from the abdominal side. Berlin blue had been introduced into the peritoneum by "natural injection." *b*. Straight interfascicular lymphatics between the bundles of tendon of the abdominal side. *a*. Lymph vessels of the pleural side, showing the valves, with corresponding dilatations. The last lymph vessels are as completely injected as the first. (Oc., 3; Obj., 4. Tube not drawn out.)

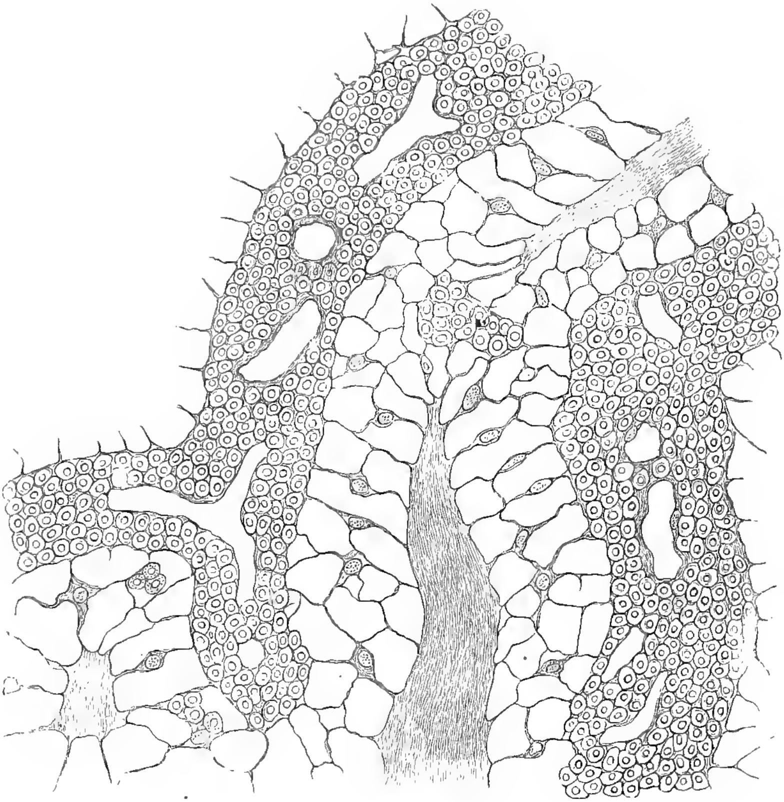


FIG. 129.—Section of medullary substance of mesenteric gland of ox, which has been hardened in Müller's liquid and then partially shaken. The figure shows the lymphatic cylinders containing blood-vessels, surrounded by closely packed lymph corpuscles, the finely fibrous trabeculæ, and the system of cells between them. The blank spaces between the trabeculæ and the cylinders represent the system of lymph sinuses, the lymph corpuscles of which have for the most part been shaken out. p. 117. (Oc., 3; Obj., 8. Tube not drawn out.)

PLATE LXI.

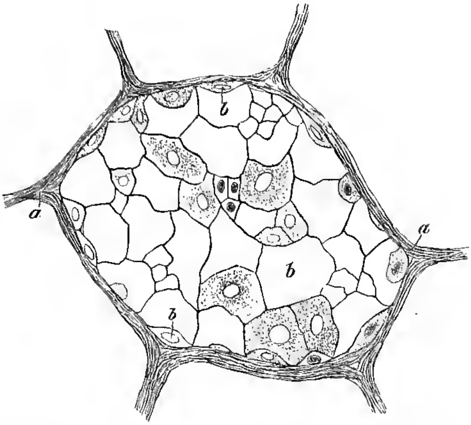


FIG. 130.—Alveolus from a section of lung of rabbit, frozen and coloured in silver. *a*. Inter alveolar septa of elastic fibres. *b*. Epithelium of the alveolus, seen from the surface. The epithelial cells are seen edgewise on the borders of the alveolus. p. 120. (Oc., 3; Obj., 7.)

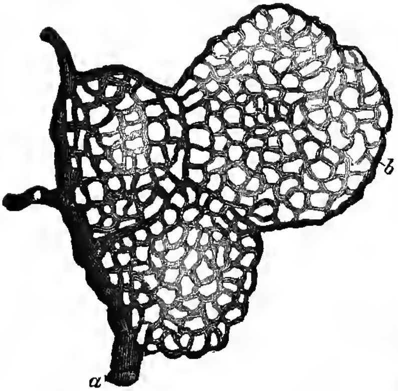


FIG. 132.—Section of a lung of a rabbit, injected through the pulmonary artery. *a*. Branch of the pulmonary artery losing itself in *b*, a dense capillary system. p. 120. (Oc., 3; Obj., 2.)

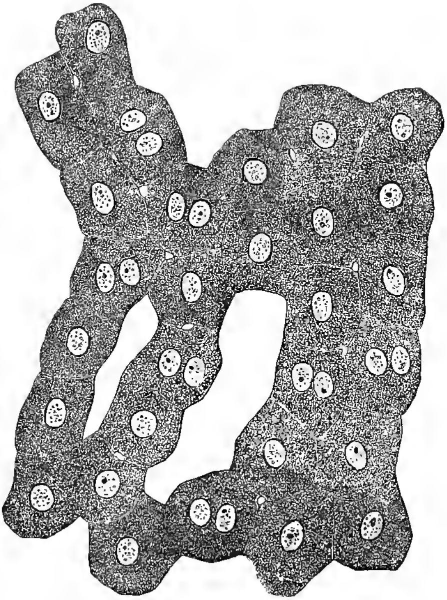


FIG. 133.—Section of liver of guineapig hardened in bichromate of potash, showing the cylindrical trabeculæ of liver cells. The spaces between the cylindrical cells correspond to capillary blood-vessels. The little openings between the constituent cells of a cylinder are capillary bile ducts cut across. p.126. (Oc., 3; Obj., 8.)

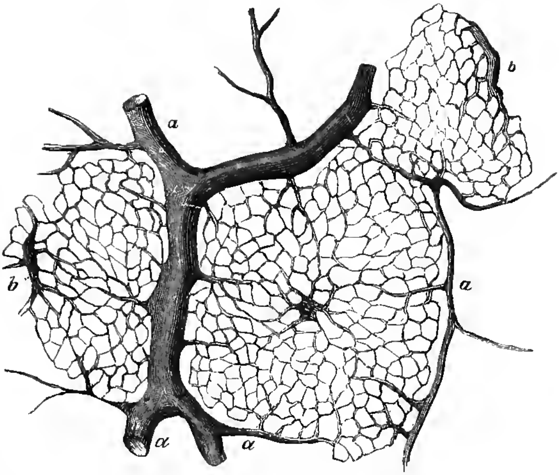


FIG. 134.—Horizontal section of liver of dog, the *vena portæ* of which has been injected. *a*. Trunk of interlobular vessel. *b*. Trunk of intralobular vessel, or *vena centralis*. A dense system of capillary vessels is between them. p. 126. (Oc., 3; Obj., 2.)

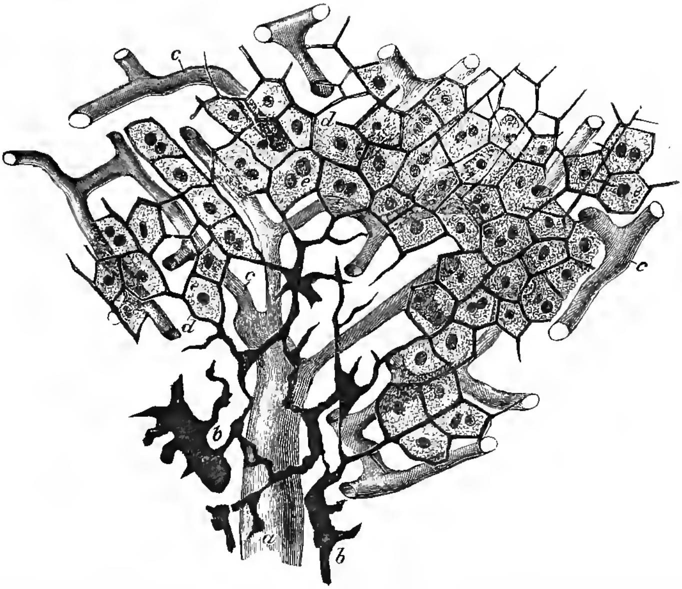
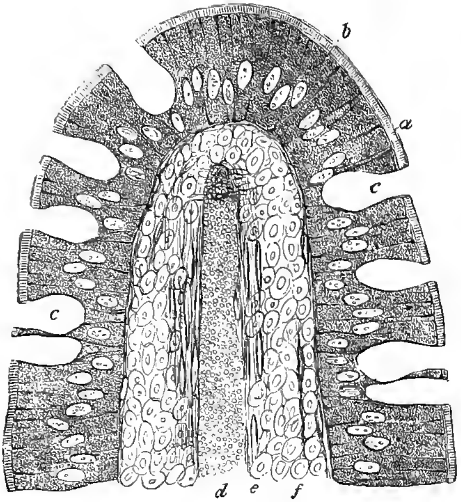


FIG. 135.—Vertical section of liver of rabbit, the portal vein and hepatic duct of which are injected. *a*. Interlobular blood-vessels. *b*. Interlobular bile ducts, forming a network. c. Intralobular capillary blood-vessels. *d*. Intralobular bile capillaries. *e*. Liver cells, the nuclei of which are deeply stained with carmine. p. 126. (Oc., 3; Obj., 5.) (*See* also fig. 142.)

PLATE LXIII.



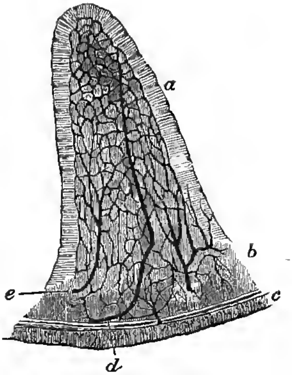
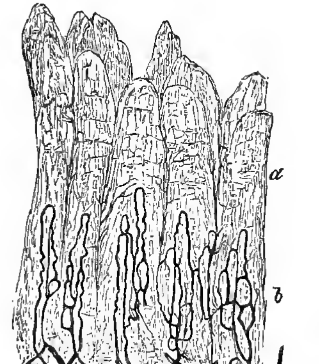


FIG. 136.—Vertical section of injected small intestine of rat. *a.* Villus showing its epithelium and dense system of capillary vessels, which is developed from a central artery *d*, and terminates in two peripheral veins, *e*. *b*. Mucosa. c. Portion of *muscularis externa*. p. 124. (Oc., 2; Obj., 2.)

FIG. 137.—Vertical section of a villus of the small intestine of a cat, hardened in chromic acid. *a*. Streaked basal border of epithelium. *b*. Cylindrical epithelium. *c*. Goblet cells. *d*. Central lymph vessel. *e*. Smooth muscular fibres which lie nearest to the lymph vessels. *f*. Adenoid stroma of the villus in which lymph corpuscles lie. p. 124. (Oc., 3; Obj., 8.)



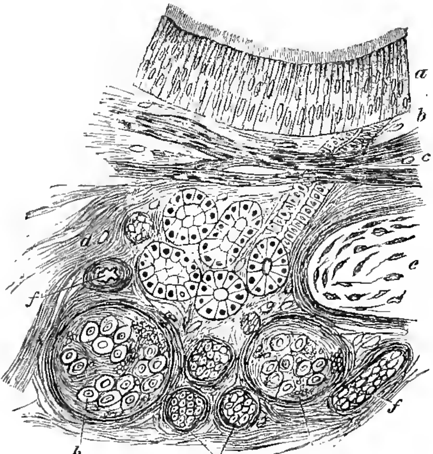


FIG. 138.—Transverse section of filiform papilla of tongue of rabbit. *a*. Epithelial covering of papillæ. *b*. Capillary loop of papillæ. c. Vessels of the mucosa. *d*. Vessels of longitudinal muscles. p. 122. (Oc., 2; Obj., 2.)

FIG. 139.—Transverse section of large bronchus of human fœtus, from a lung hardened in chromic acid. *a*. Ciliated cylindrical epithelium in layers. *b*. Mucosa. *c*. Bundles of unstriped muscular fibre. *d*. Submucous tissue, showing cross sections of gland tubes. *e*. Portion of cartilaginous ring. *f*. On the left, an artery cut through; on the right, below, a vein. *g*. Trunks of medullated nerve fibre cut through. *h*. Section of ganglion. p. 120. (Oc., 3; Obj., 4. Tube not drawn out.)

(For figures of retina referred to in the text, *see* figs. 157 and 158.)

PLATE LXIV.

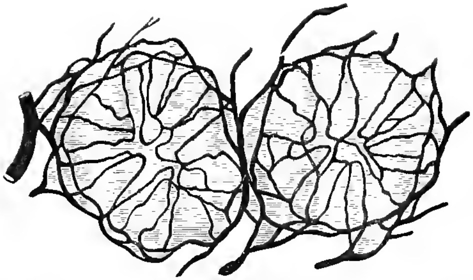


FIG. 140.—Two injected follicles from transverse section of Peyer's patches of small intestine of rabbit. Out of the plexus of large vessels which surrounds the follicle, numerous capillaries are developed, which tend towards the centre of the follicle, and for the most part turn back so as to form loops. p. 125. (Oc., 3 Obj., 2.)

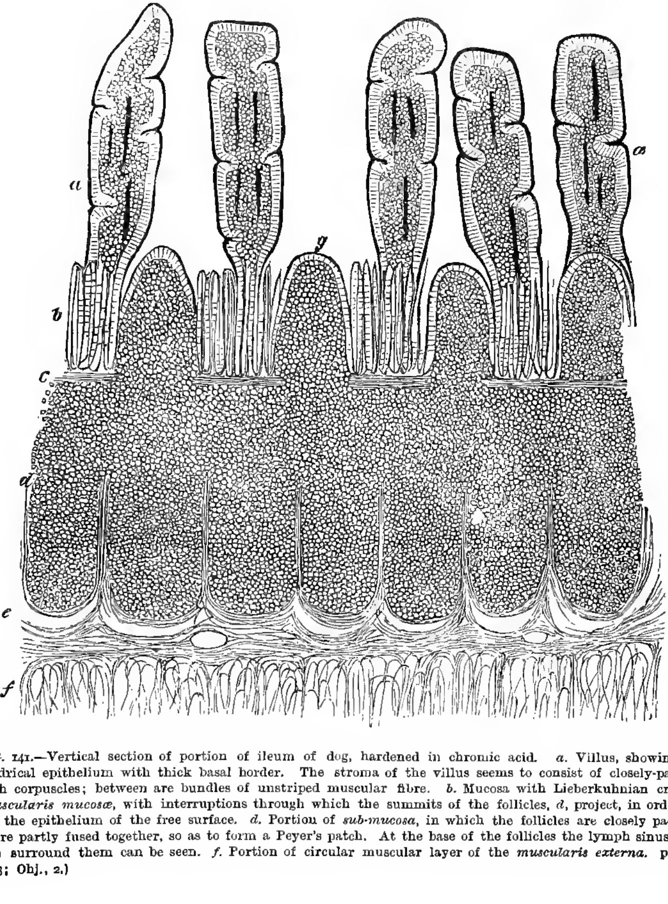


FIG. 141.—Vertical section of portion of ileum of dog, hardened in chromic acid. *a*. Villus, showing its cylindrical epithelium with thick basal border. The stroma of the villus seems to consist of closely-packed lymph corpuscles; between are bundles of unstriped muscular fibre. *b*. Mucosa with Lieberkuhnian crypts. c. *Muscularis mucosæ*, with interruptions through which the summits of the follicles, *d*, project, in order to reach the epithelium of the free surface. *d*. Portion of *sub-mucosa*, in which the follicles are closely packed, and are partly fused together, so as to form a Peyer's patch. At the base of the follicles the lymph sinuses, *e*, which surround them can be seen. *f*. Portion of circular muscular layer of the *muscularis externa*. p. 126, Oc., 3; Obj., 2.)

PLATE LXV.

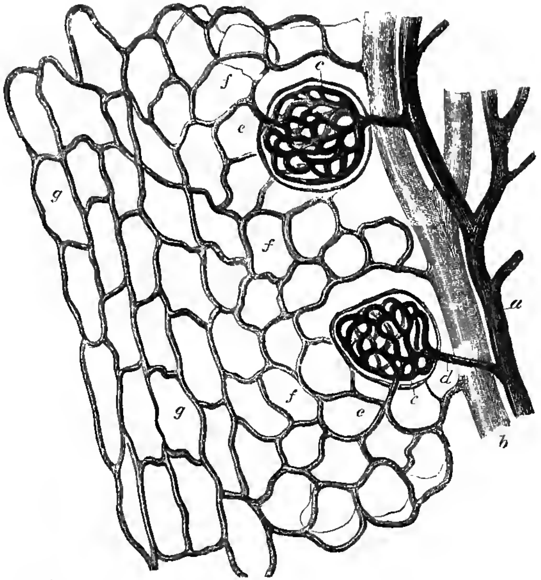
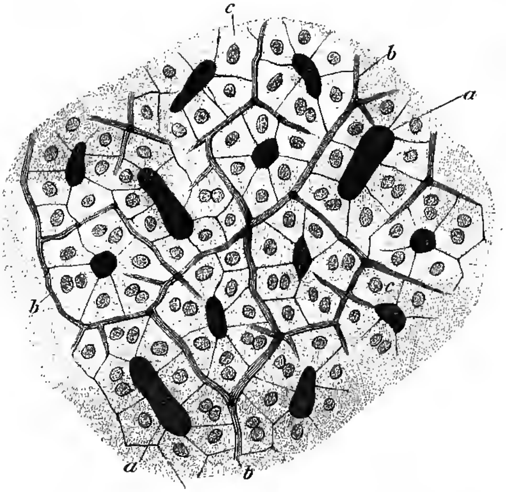


FIG. 143.—From a longitudinal section of the injected kidney of a rat. *a*. Arterial trunk. *b*. Venous trunk. *c*. Glomerulus. *d*. Vas afferens of the glomerulus. *e*. Vas efferens. *f*. Capillaries which twine round the convoluted tubes. *g*. Capillary vessels of the pyramidal processes. p. 134. (Oc., 3; Obj., 4.)



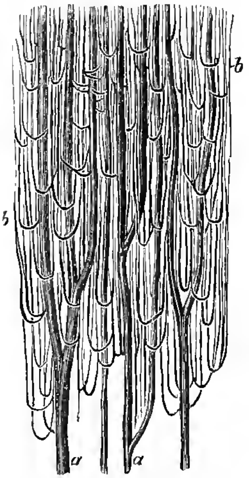


FIG. 142.—Section, parallel with the surface, of an acinus of the same preparation as fig. 135. *a*. Intralobular capillary blood-vessel. *b*. Intralobular capillary bile duct. *c*. Liver cells. p. 126. (Oc., 3; Obj., 7.) (*See* also fig. 135.)

FIG. 144.—From a kidney of pig injected from the ureter, showing the arrangement of the tubes in the pyramidal substance. *a*. Collecting tubes. *b*. Henle's loops. p. 134. (Oc., 3; Obj., 2.)

PLATE LXVI.

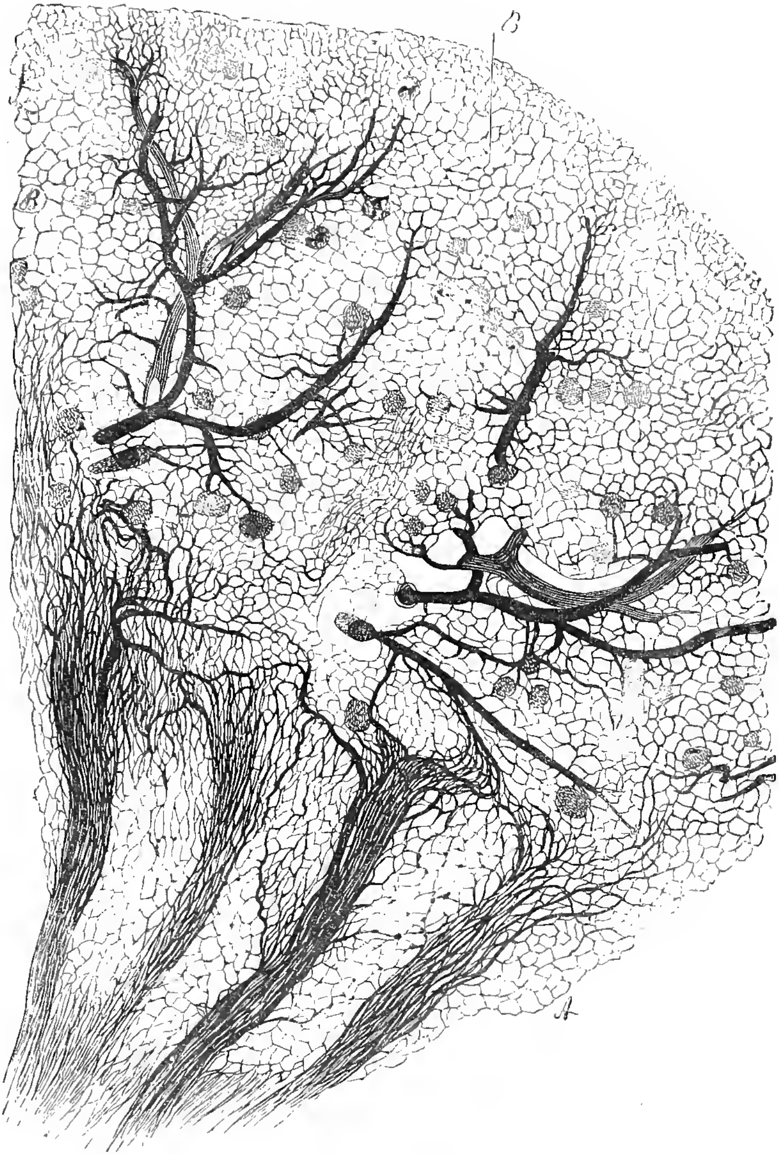
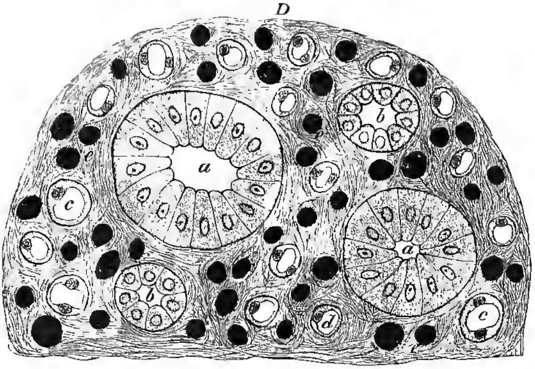


FIG. 145.—Transverse section across the axis of the injected kidney of a rat. At A are seen the bundles of the vasa recta, which penetrate the pyramids. B. Cortical substance. p. 134. (Oc., 3; Obj., 2.)

Plate LXVII.



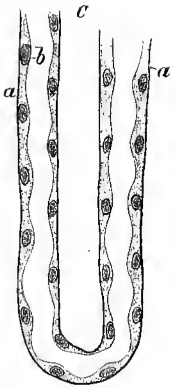
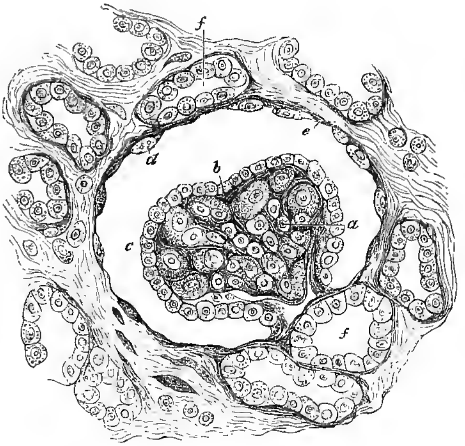


FIG. 146.—Transverse section of pyramidal substance of kidney of pig, the blood-vessels of which are injected. *a*. Large collecting tube, cut across, lined with cylindrical epithelium. *b*. Branch of collecting tube, cut across, lined with epithelium with shorter cylinders. *c* and *d*, Henle's loops cut across. *e*. Blood-vessels cut across. D. Connective tissue ground-substance. p. 132.

FIG. 147.—Teased preparation from a section of kidney of pig, hardened in bichromate of potash, showing a Henle's loop. *a*. *Membrana propria*. *b*. Epithelium.



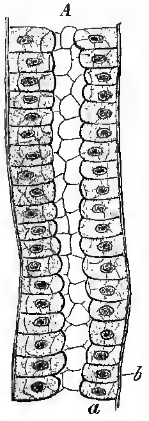


FIG. 148.—The same, showing a portion of a collecting tube in the pyramidal processes of the corticalis. A shows the lumen of the tube; *b*, the *membrana propria*; *a*, the cylindrical epithelium. p. 132. (Oc., 3.)

FIG. 149.—Section of cortical substance of kidney of human fœtus, hardened in bichromate of potash. *a*. Glomerulus with (*b*) its *membrana propria*; and *c*, the epithelium of polyhedric cells covering the glomerulus. This epithelium is continuous with *d*, the flattened epithelium which lies upon the inner surface of the Bowman's capsule, *c*. *f*. Convoluted urinary tube cut across. p. 132. (*See* also fig. 155.)

PLATE LXVIII.

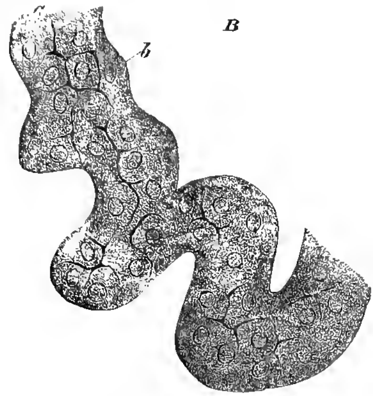
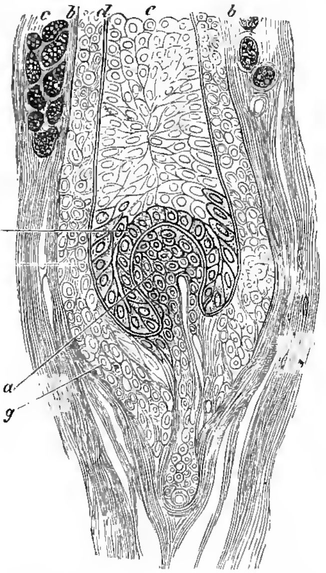


FIG. 150.—Portion of convoluted tube of kidney of pig, prepared with bichromate of potash. The granular substance which fills the tube contains nuclei, many of which are surrounded by areas the limits of which are faintly indicated. *b. Membrana propria.* p. 132. (Oc., 3.)



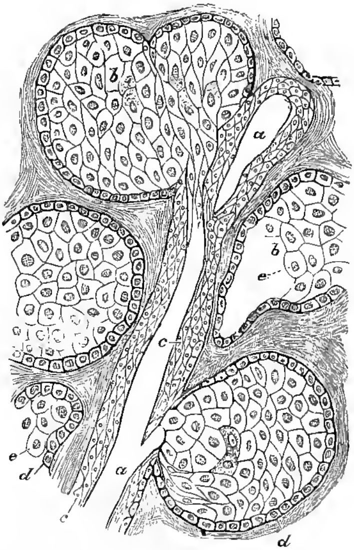
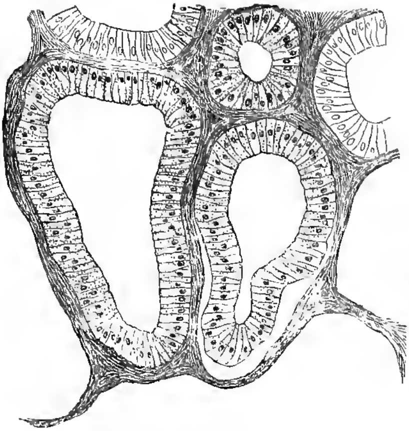


FIG. 151.—Longitudinal section of eyelash of newly-born child, hardened in chromic acid. *a.* The papilla. *b.* Layer of longitudinal fibres of hair bulb. *c.* Muscular fibre of the *musculus ciliaris albini* cut transversely. *d.* Hyaline membrane which separates the inner layer (*g*) of the hair bulb (here cut through), which consists of transverse unstriped muscular fibre, and *e*, the external sheath of the root. This hyaline membrane extends uninterruptedly over the papilla. *f.* Outermost cylindrical cells of the external root sheath, which cover the hyaline membrane of the papilla. p. 131.

FIG. 152.—Portion of a Meibomian follicle from a vertical section of human eyelid, hardened in chromic acid. *a.* Principal duct, with its lining of pavement epithelium, c. *b.* The acini which communicate by channels with the principal duct. These acini are bounded by a layer of polyhedral cells, consisting of granular protoplasm, which lines the *membrana propria.* These cells are directly continuous with the deep cell layer of the duct. *e.* Polyhedral cells filling the acinus, which are flattened against each other, and which, in preparations treated with alcohol and oil of cloves, are seen to contain each a nucleus. p. 131.

PLATE LXIX.



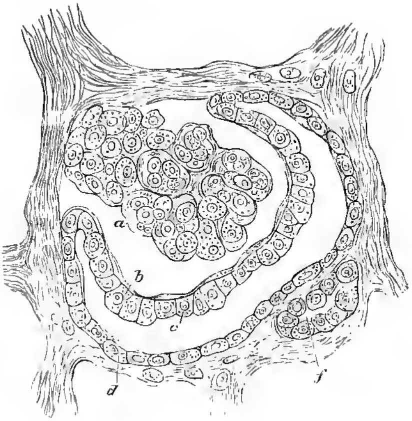


FIG. 153.—Tubular glands of human prostate, hardened in chromic acid, showing the cylindrical epithelium which covers them. p. 137.

FIG. 154.—Section of cortical substance of kidney of six months' human fœtus, hardened in bichromate of potash. *a.* Glomerulus. *b.* *Membrana propria*, which extends over the glomerulus, and which is a direct continuation of Bowman's capsule. At the point of section it appears as if it consisted of spindle-shaped elements placed together. *c.* The epithelium of cylindrical elements which covers the glomerulus. *d.* Epithelium of polyhedral cells which lines Bowman's capsule. *f.* Convoluted urinary tube cut through transversely. p. 132. (*See* also fig. 149.)

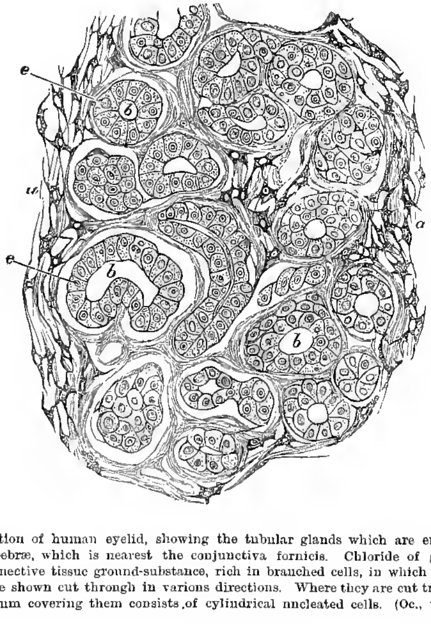


FIG. 155.—Vertical section of human eyelid, showing the tubular glands which are embedded in that part of the conjunctiva palpebræ, which is nearest the conjunctiva fornicis. Chloride of gold preparation, hardened in alcohol. *a.* Connective tissue ground-substance, rich in branched cells, in which the tubular glands (*b*) are embedded. These are shown cut through in various directions. Where they are cut transversely, as at *e*, it is seen that the epithelium covering them consists of cylindrical nucleated cells. (Oc., 3; Obj., 8.)

PLATE LXX.

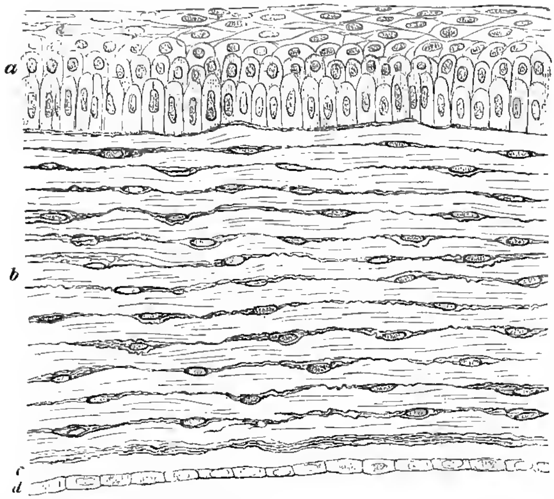


FIG. 156.—Vertical section of cornea of rabbit, hardened in chromic acid. *a*. Anterior layer of pavement epithelium. *b*. *Substantia propria* of the cornea, consisting of connective tissue fibres in more or less parallel bundles, between which are the cornea corpuscles. These, in vertical sections, appear spindle-shaped. *c*. The posterior lamina elastica, or Descemet's membrane, and the endothelium of polyhedral cells, *d*, which covers it. p. 138.

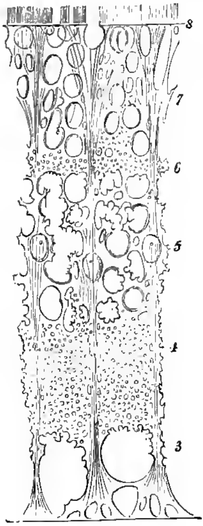


FIG. 157.—Diagram of the connective substance of the retina.

FIG. 158.—Diagram of the nervous elements of the retina (after Max Schultze). These two diagrams must be supposed to fit into one another in such a way that the nervous elements fill corresponding spaces in the connective substance. In 157, the lower line represents the *limitans interna*; the line 8 the *limitans externa*. 2. Layer of nerve fibres. 3. Layer of ganglion cells. 4. Inner finely granular, or, more correctly, finely fibrillated layer which really forms an extremely close network of very fine fibres into which, on the one hand, the processes of the ganglion cells penetrate; out of which, on the other hand, the fibres of the inner granular layer, 5, proceed. The outer processes of the elements of this layer similarly terminate in a close finely fibrillar network, 6, the intermediate granular layer or outer finely granular, or, more correctly, finely fibrillar layer. Out of this proceed the inner processes of the outer granular layer, 7, which terminate as rods and cones, 9. p. 142.

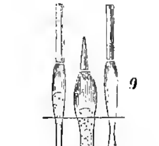
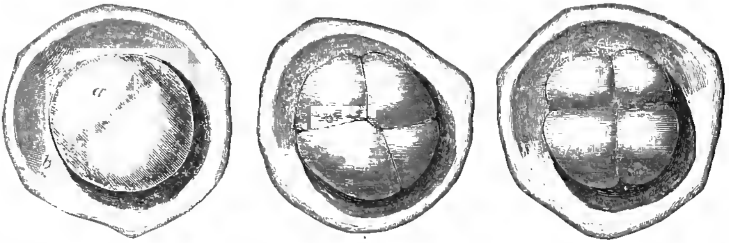
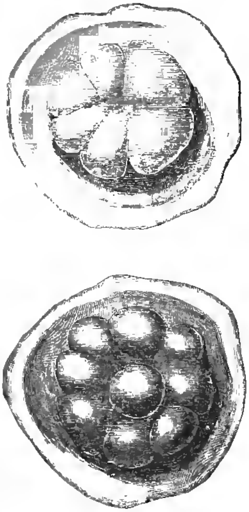


PLATE LXXI.



FIGS 159-163.—Various stages of cleavage of the egg of the trout. *a.* Germ. *b.* Section of yolk on which the germ lies. p. 148. (These figures are referred to in the text, by error, as 146-150.)



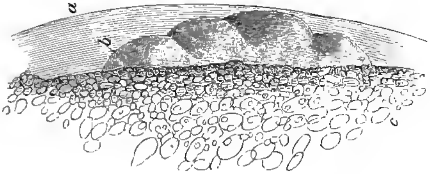


FIG. 164.—Germ in an early stage of cleavage, seen in profile. *a.* Vitelline membrane. *b.* Germ. *c.* Yolk.

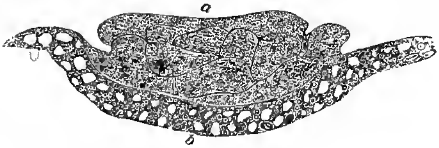


FIG. 165.—Vertical section of blastoderm of the egg of a trout at the third day. *a.* Germ, already split into a large number of elements, in some of which the dark yolk granules can be distinctly recognized. *b.* Yolk of the saucer-shaped depression, filled with fat globules.

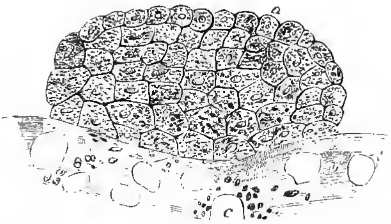


FIG. 166.—Similar preparation, made at the sixth day. The blastoderm, which lies on the yolk like a cushion, consists, as in the previous figure, of small, distinctly nucleated elements. The deeper elements, those not so far advanced in cleavage, are larger, and still contain yolk granules.

PLATE LXXII.

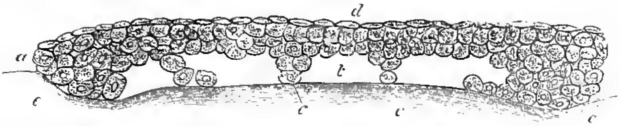


FIG. 167.—Similar preparation at the twelfth day. The blastoderm has increased considerably in width, and shows at *a* a marginal thickening. Opposite the thinner central portion, *d*, the blastoderm is separated from the yolk, *c*, by a hollow space, the cleavage cavity, *b*. It is still, however, connected with the yolk by columns of cells, the sub-germinal processes.

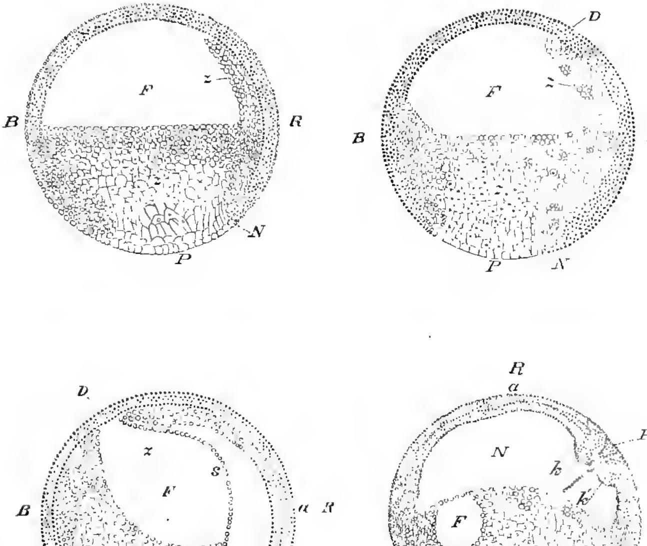


FIG. 169-172.—Sections of the egg of bufo cinereus, intended to show the relations between the cleavage cavity and Rusconi's cavity, eventually the visceral cavity (after Stricker). R. The dorsal aspect of the egg. B. The ventral aspect. F. Baer's cleavage cavity. N. In 169 and 170, Rusconi's cleft; in 172, Rusconi's cavity (*Nahrungshöhle*). D. Dome of the cleavage cavity, consisting of elements in an advanced stage of cleavage, and representing the original upper pole of the egg. P. Original lower pole of the egg, showing, especially in 171 and 172, Ecker's yolk plug. z. Elements of the margins of the cleavage cavity (central yolk mass of Reichert). They are larger, that is, less advanced in cleavage, than the elements in the dome of the cleavage cavity or of Rusconi's cavity. In 169, they are making their way along the inner surface of the cover of the cleavage cavity towards the upper pole. They answer to the formative elements of the trout's egg. Rusconi's cleft advances between these elements, so that in 171, where the cleft has become a cavity, they are separated from the cleavage cavity by a layer of formative elements, *s*. In 172, owing to the alteration in its centre of gravity, the egg has changed its position, the white pole being now nearly uppermost. p. 152.

PLATE LXXIII.

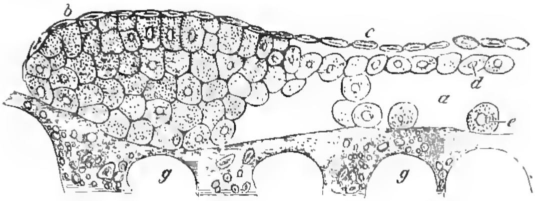


FIG. 168.—Vertical section of peripheral part of blastoderm of trout's egg at the fourteenth day. *b.* Marginal thickening. *c.* Central thin portion of blastoderm, showing superficially a layer of flattened elements, under which is a layer of spheroidal elements, *d.* The blastoderm rests on the yolk by means of the sub-germinal processes, as in fig. 167. The formative elements, *e*, on the floor of the cleavage cavity, *a*, are derived from the blastoderm; either from the sub-germinal processes, or from the lower layer, *d*, of the central portion. *f.* Yolk of the saucer-shaped depression. *g.* Vacuoles (fat globules?).

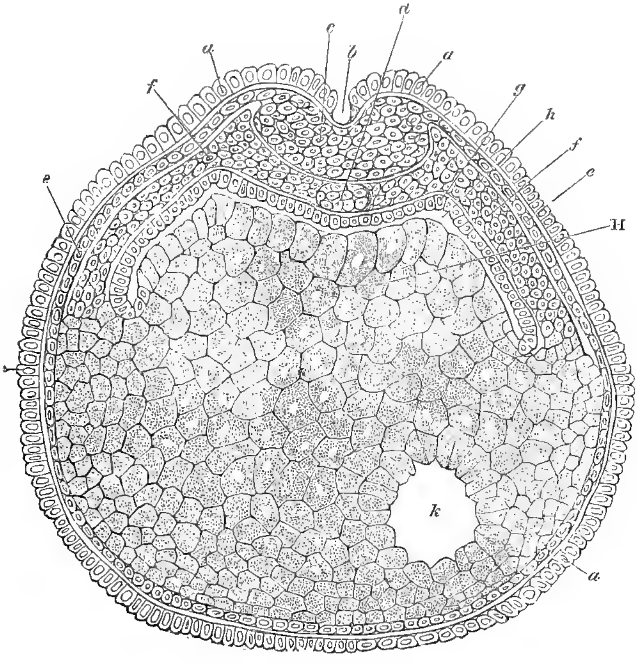


FIG. 173.—Vertical section of the dorsal furrow of the commencing embryo of bufo cinereus. *a.* Cornea layer. *b.* Dorsal furrow. *c.* Commencing central nervous system. *d.* Commencing *chorda dorsalis.* *e.* Peripheral portion of nervous layer. *f.* Peripheral portion of the third or motor-germinative layer. *g.* Fourth or epithelial glandular layer. *h.* Rusconi's cavity. H. Elements of Reichert's central yolk mass. *k.* The remainder of the cleavage cavity. p. 153.

PLATE LXXIV.

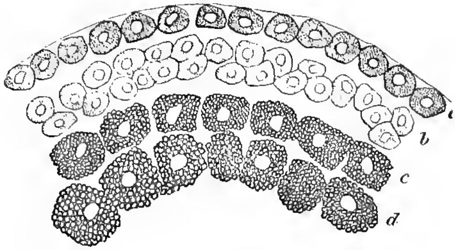


FIG. 174.—Section of the cover or dome of Rusconi's cavity (Bufo). *a.* Corneal layer. *b.* Nervous layer. *c.* Motor-germinative layer. *d.* Epithelial glandular layer. *c* and *d* are the offspring of formative elements.

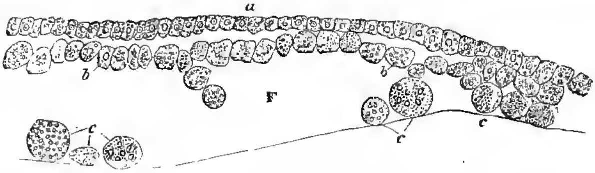


FIG. 175.—Vertical section of a portion of the *area pellucida* and *area opaca* of the blastoderm of a fresh-laid hen's egg. In the section corresponding to the *area pellucida*, the blastoderm consists of two distinct layers, *a* the upper, and *b* the lower; the latter looser and consisting of larger elements. *cc.* Formative elements lying on the floor of the cleavage cavity F, which have originated from the germ, and are filled with yolk granules. These elements are continuous with similar ones in the *area opaca.*

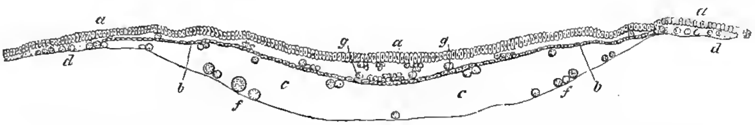


FIG. 176.—Section of blastoderm of hen's egg, at the fifteenth hour of incubation. *a.* Upper, and *b* lower layer. *c.* Cleavage cavity. *d.* Yolk rim. *f.* Formative elements on the floor of the cleavage cavity. *g.* Similar elements which have already migrated in between the layers of the blastoderm.

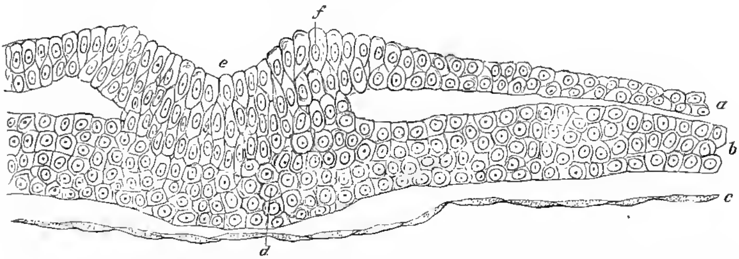


FIG. 177.—Section of commencing embryo at the twenty-sixth hour after incubation. *a.* Upper, *b* middle, *c* under layer. *d.* Central portion of the middle layer, which is here fused with the upper layer. *e.* Primitive groove. *f.* Dorsal ridges.

Plate LXXV.

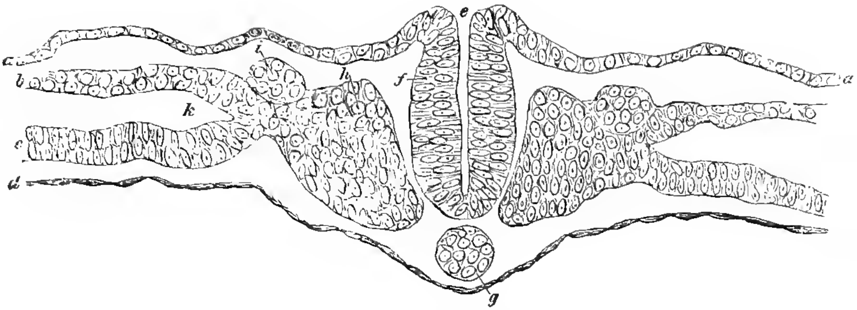


FIG. 178.—Similar preparation at the thirty-sixth hour. *a.* Upper layer. *b.* Parietal lamella, *lamina ventralis* (*Hautmuskelplatte*). *c. Lamina serosa*, visceral lamella (*Darmfaserplatte*). *d.* Lower layer. *f.* Central nervous system. *g. Chorda dorsalis. h.* Proto-vertebræ. *i.* Wollfian body. *k.* Pleuro-peritoneal fissure. *b, c, h, i, g*, are products of differentiation of the middle layer. p. 156.

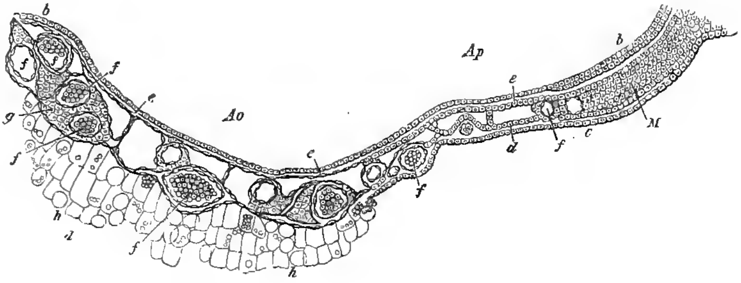


FIG. 179.—Section of *area opaca*, and a portion of *area pellucida* of blastoderm (caudal end), at the thirtieth hour. *Ap. Area pellucida. Ao. Area opaca. b.* Upper, c under, M middle layer of germ *e. Lamina ventralis. d. Lamina serosa. f.* Blood-vessels. *g.* Elements which belong to the middle layer, and particularly to the *lamina serosa. h.* Yolk of the inner yolk rim.

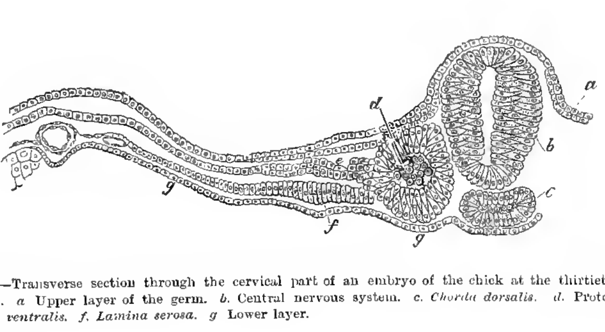


FIG. 180.—Transverse section through the cervical part of an embryo of the chick at the thirtieth hour of incubation. *a* Upper layer of the germ. *b.* Central nervous system. *c. Chorda dorsalis. d.* Proto-vertebræ. *e. Lamina ventralis. f. Lamina serosa. g* Lower layer.

PLATE LXXVI.

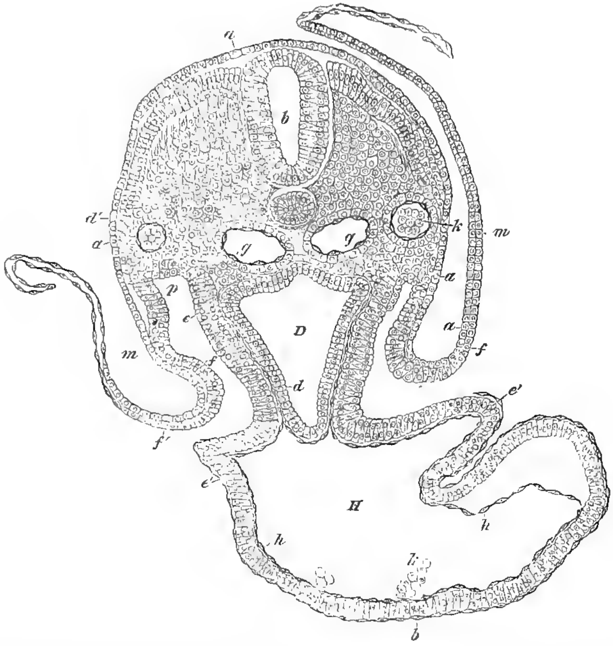


FIG. 181.—Section of embryo of chick at the beginning of the second day, in the neighbourhood of the heart. *a.* Upper or corneal layer. *b.* Central canal of the central nervous system. *d.* Under or epithelial glandular layer. D. Anterior intestine (Vorderdarm). *c. Lamina serosa. f. Lamina ventralis. g.* Aortæ. *k. Venæ cardinales. m.* Fold of amnios. *p.* Pleuro-peritoneal cavity. H. Heart cavity. *h.* Endothelium of wall of heart. *e'.* Proper wall of heart. *k.* Blood corpuscles.

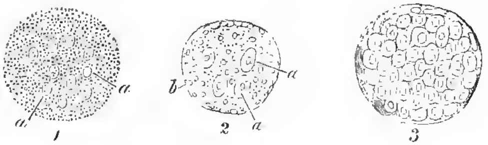


FIG. 187.—Transition of the formative elements of the blastoderm into endothelial vesicles containing blood corpuscles (endogenous development of blood corpuscles). 1. Coarsely granular formative element in which isolated nuclei, *a*, are found. 2. Numerous nuclei, and a few blood corpuscles, *a*, are distinguishable, while a peripheral zone, *b*, begins to be differentiated from the rest of the cell. In 3, the peripheral nucleated layer of finely granular protoplasm has become distinct from the contents, which consist entirely of coloured blood corpuscles, so that we have before us a vesicle lined with endothelium and filled with blood corpuscles. The lining of finely granular protoplasm, with its more or less regularly arranged nuclei, represents the endothelium of a future vessel.

PLATE LXXVII.

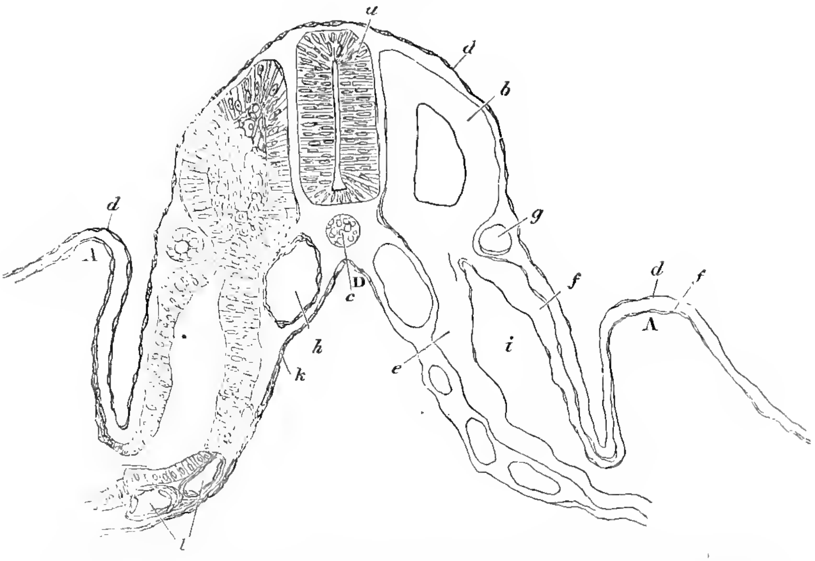


FIG. 182.—Section of the posterior part of the body of the embryo of the chick at the forty-eighth hour. *a*. Central nervous system. *b*. Proto-vertebræ. *c*. *Chorda dorsalis*. *d*. Upper or corneal layer. *e*. Serous, and *f*. ventral lamina. *g*. Wolffian duct. *h*. Aortæ. *i*. Pleuro-peritoneal cavity. *k*. Lower layer. D. Intestinal furrow. A. Amniotic fold. *l*. Blood vessels.

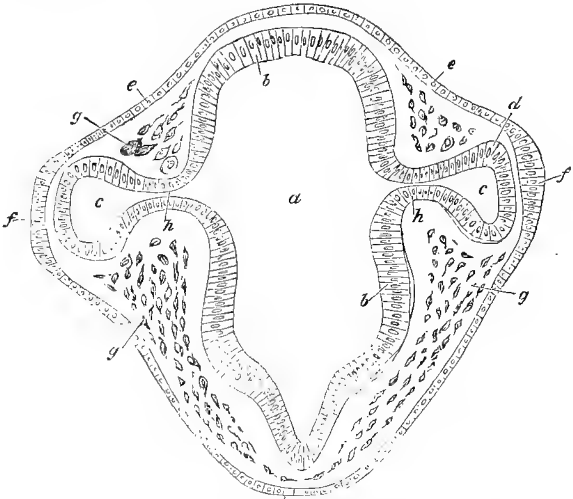
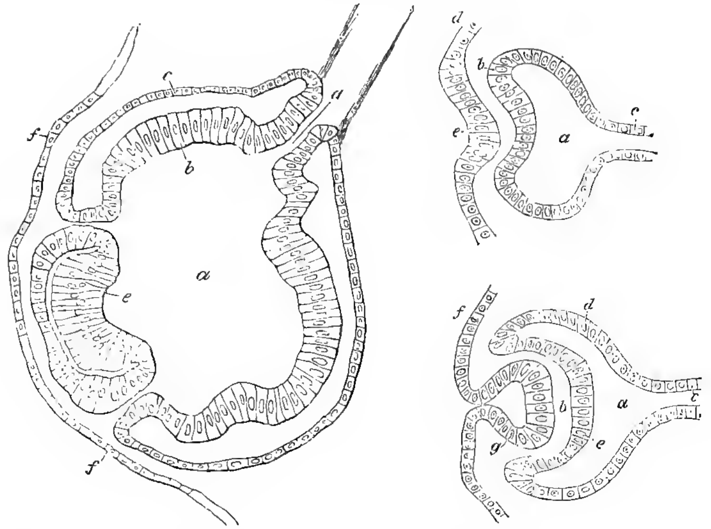


FIG. 183.—Section of anterior cerebral vesicle of embryo at the middle of the second day. *a*. Cavity of anterior cerebral vesicle. *b*. Wall of cerebral vesicle. *c*. Primary optic vesicle, and *d* its wall. *e*. Upper layer of germ. *f*. Thickening of the upper layer for the formation of the lens. *g*. Middle layer. *h*. *Nervus opticus*. p. 157.

PLATE LXXVIII.



FIGS. 184–186.—Various stages in the transition of the primary into the secondary optic vesicle, and the development of the lens at the end of the second and during the third day.

186. *a.* Cavity of secondary optic vesicle. *b.* Rudiment of retina. *c.* Rudiment of pigment epithelium of the choroid. *d. Nervus opticus.* *e.* Lens. *f.* Upper or corneal layer.

184. *a.* Primary optic vesicle, and *b* its wall. *c. Nervus opticus.* *d.* Upper or corneal layer. *e.* Beginning of lens.

185. *a.* Primary optic vesicle. *b.* Saucer shaped cavity, which subsequently becomes the secondary optic vesicle. *c. Nervus opticus.* *d.* Outer wall, and *e* inner wall, of primary optic vesicle. *f.* Upper or corneal layer. *g.* Rudiment of lens.

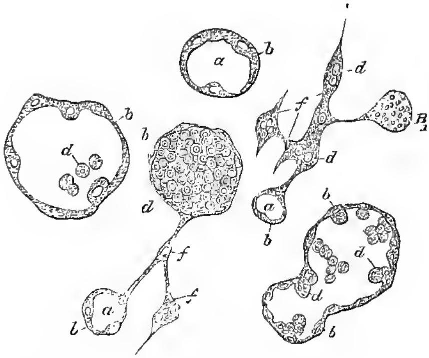
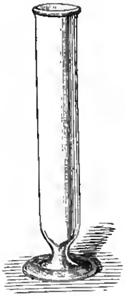
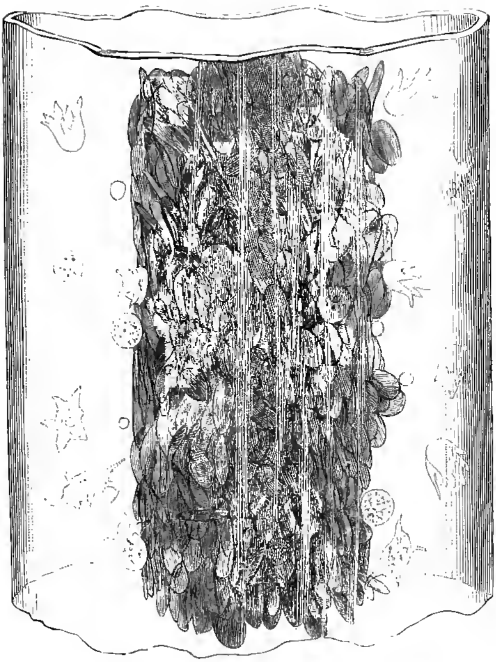


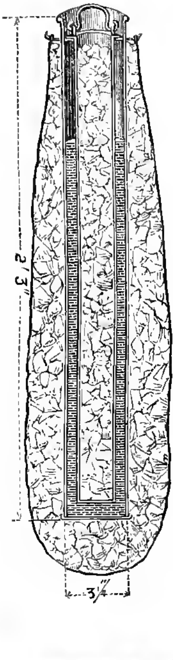
FIG. 188.—Other forms of elements, in which blood corpuscles are produced. *a*, *a*, are the cavities of vesicular structures, produced by the formation of vacuoles, in originally solid cells. The wall of the vesicle *b*, which consists of nucleated protoplasm, represents the endothelium of the future vessel, for which reason these vesicles may be called endothelial vesicles. At *d*, blood corpuscles are detaching themselves from the inner portion of a vesicle. *f*. Shows an element of another kind, in which blood corpuscles are formed. It is a spindle-shaped or branched solid cell, the central portion of which becomes blood corpuscles, and the peripheral portion endothelium. *b*. Is an element similar to that in fig. 187.

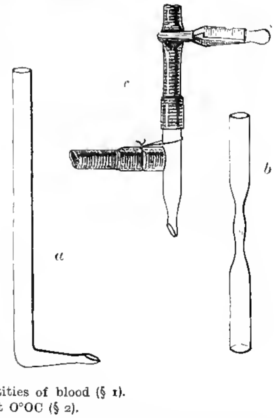
These three varieties of formative elements of blood corpuscles are in communication with each other by solid offshoots. They have this in common, that in all a peripheral layer of nucleated protoplasm is differentiated from the interior, which contains a greater or less number of blood corpuscles. The interiors of neighbouring elements eventually become continuous with each other by the offshoots or communicating threads above mentioned, which become hollowed out, and thus give rise to a system of tubes, the blood-vessels.

PLATE LXXIX.









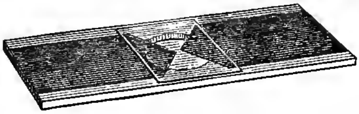


FIG. 190.—Test-tube, with foot, used for subsidence of small quantities of blood (§ 1).

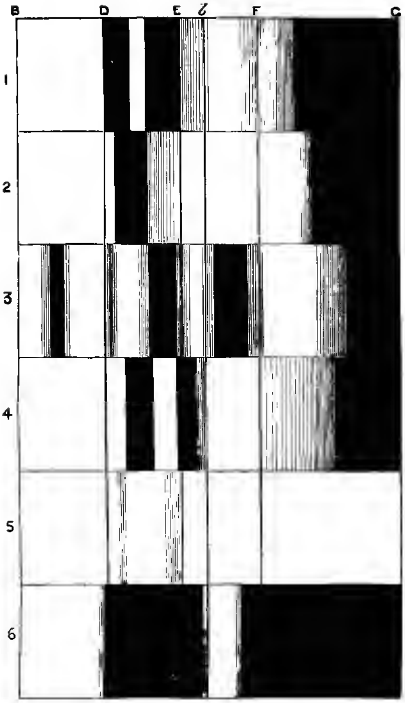
FIG. 191.—Vessel of tin plate for collecting blood and keeping it at 0°OC (§ 2).

FIG. 192.—Coagulation of blood of frog in a fine capillary tube. Hartnack. (Obj. 9; immersion. Oc. 3.)

FIG. 193.—*a*. Cannula for Schäfer's experiment. *b* shows the form into which a tube is drawn out for the preparation of an arterial cannula (§ 9); the tube is first severed at one of the constrictions, and then filed away in the direction of the oblique line. *c*. T-shaped arterial cannula; the horizontal tube is in communication with the manometer of the kymograph (§ 33).

FIG. 194.—Object-glass for studying the action of induction shocks on blood. The drop of blood to be examined is placed between the tinfoil points on the under surface of the fixed square cover-glass. The chamber is closed by placing a second ordinary object-glass below it (§ 13).

PLATE LXXX.



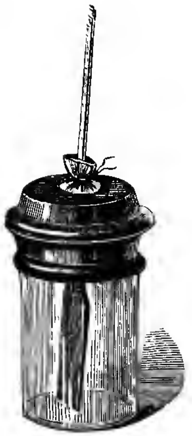


FIG. 196. — Hoppe-Seyler's bottle for preparing fibrin (§ 23).

FIG. 195.—Various absorption spectra. 1. 0·4 per cent. solution of hæmoglobin. 2. Reduced hæmoglobin (§ 18). 3. Hæmatoin (§ 22). 4. Reduced hæmatin (§ 21). 5. 0·06 per cent. solution of hæmoglobin. 6. 0·7 per cent. solution of the same (§ 24).

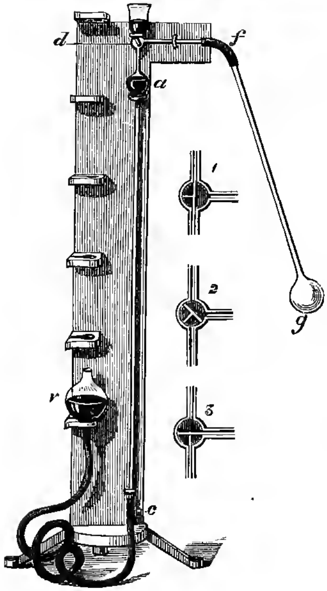


FIG. 197.—Alvergniat's mercurial pump (§ 26).

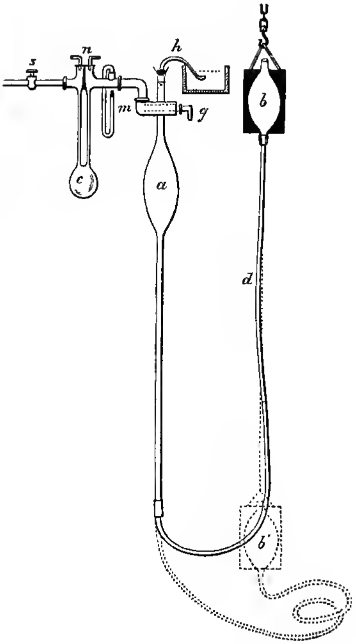


FIG. 198.—Geissler's mercurial pump (§ 27)

Plate LXXXI.

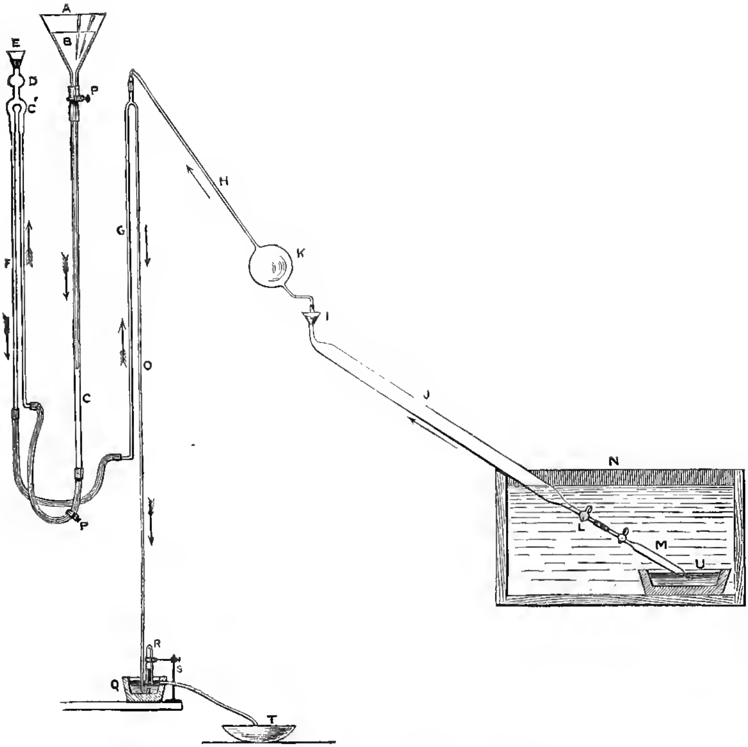


Fig. 199.—Frankland-Sprengel pump (§ 28).

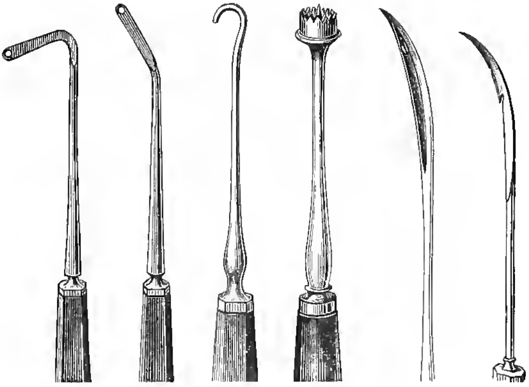


Fig. 203.—*a* and *b*. Needles for passing ligatures under vessels or nerves. *c*. Brücke's blunt hook. *d*. Trephine. *e*. Curved needle. *f*. Curved and notched needle.

PLATE LXXXII.

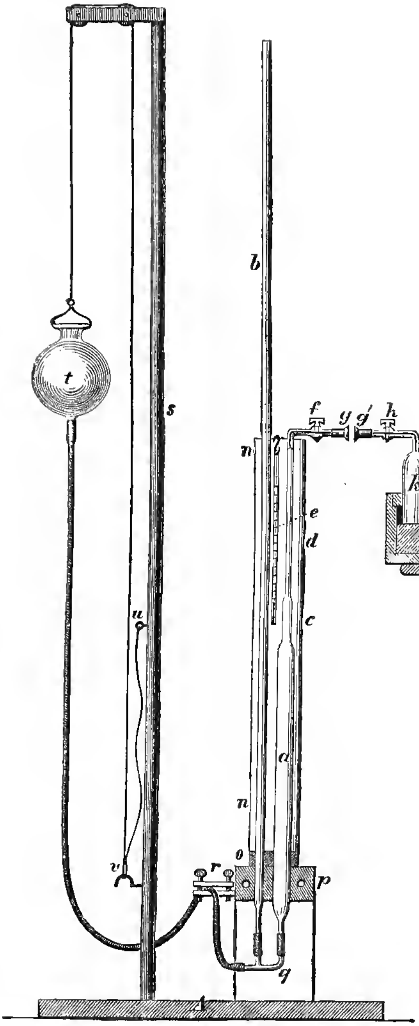


FIG. 200.—Frankland's apparatus for the analysis of gases by absorption (§ 30). (From Sutton's Volum. Analysis.)

Plate LXXXIII.

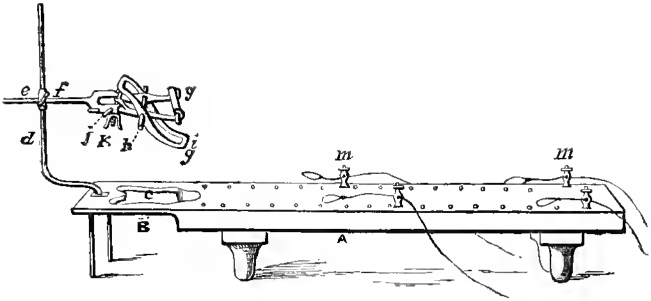


FIG. 204.—Czermak's rabbit support (§ 34).

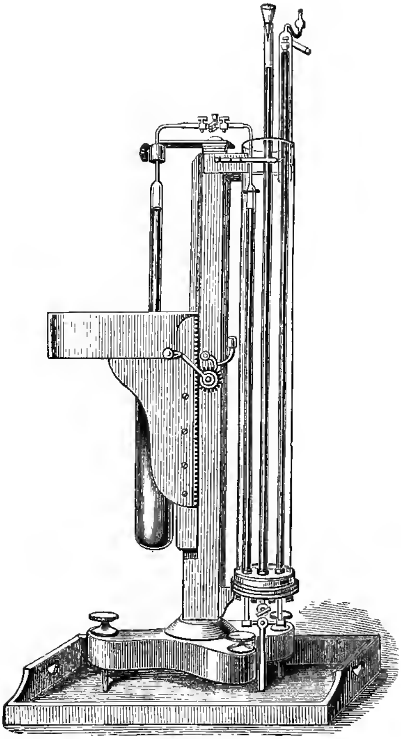


FIG. 201.—Frankland and Ward's apparatus for explosion (§ 31). (From Sutton's Volum. Analysis.)

PLATE LXXXIV.

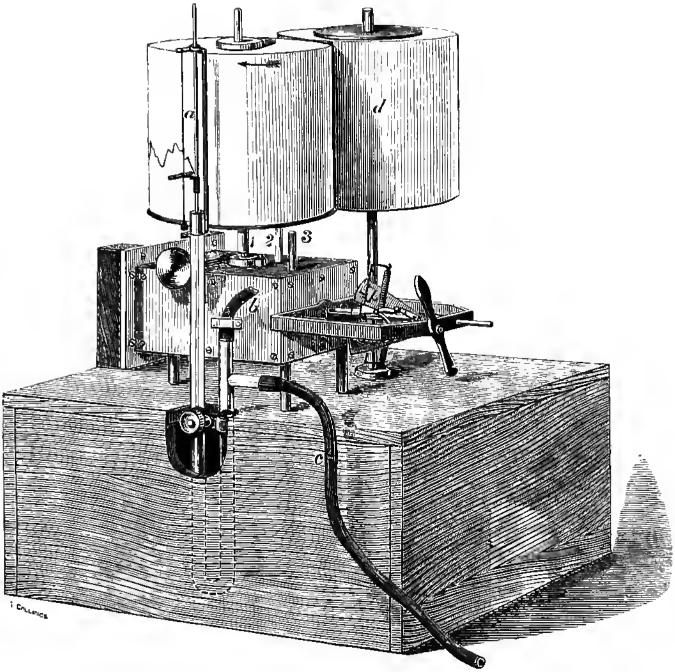


FIG. 202.—The mercurial kymograph. *a*. Vulcanite rod of floating piston. *b*. Tube which communicates with the pressure bottle. c. Tube which communicates with the artery. *d*. Feeding cylinder. 1. First axis, which revolves once in a minute. 2. Second axis, which revolves once in ten seconds. 3. Third axis, in a second and a half (§ 33). The instrument is furnished with other cylinders suitable for the reception of single bands of glazed paper, the surface of which can be blackened after they are fixed on to the cylinders, by causing the latter to revolve over the flame of a petroleum lamp. These cylinders can be fitted on to either of the axes 1, 2, or 3, and are always used when it is necessary to employ a rapidly-moving surface, as, *e.g.*, for tracing the curves of muscular contraction.

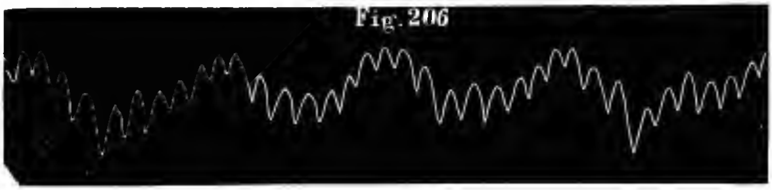


FIG. 206.—Normal tracing of arterial pressure obtained with the mercurial kymograph (rabbit).

PLATE LXXXV.

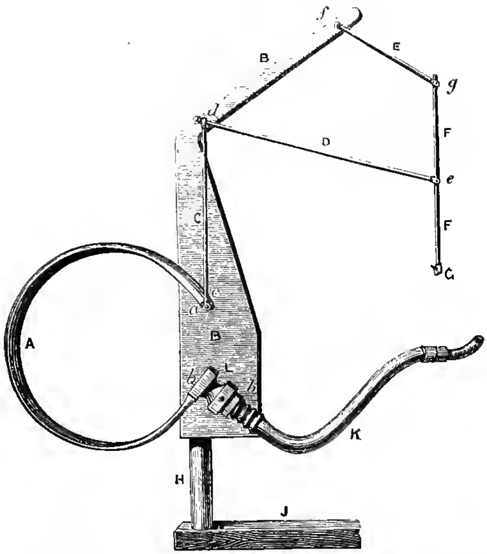
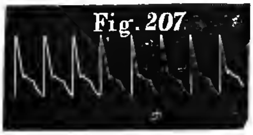


FIG. 205.—Fick's spring kymograph. A. C-spring. BB. Support. C. Rod which communicates the movements of the spring to the lever D, and thus to the writing-needle G. K. Leaden tube by which the cavity of the spring is in communication with the artery.



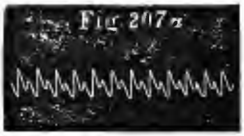


FIG. 207.—Normal arterial tracing obtained with the spring kymograph (dog under curare).
FIG. 207*a*.—Tracing of same animal after exhaustion of vagus by repeated excitations; dicrotous pulse.

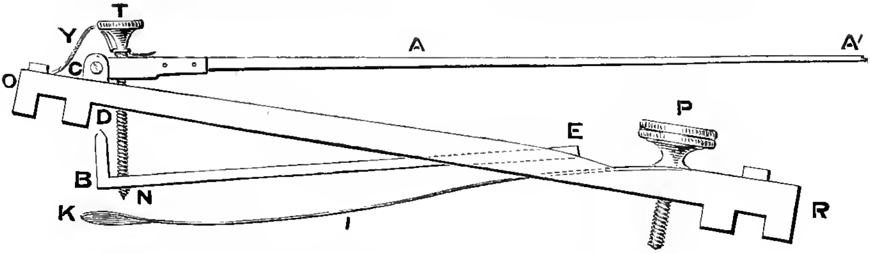
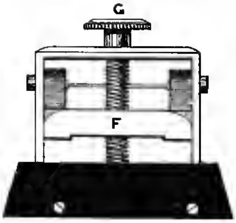
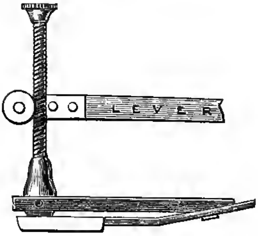


FIG. 208.—Mechanical arrangement of the sphygmograph (§ 38).

PLATE LXXXVI.





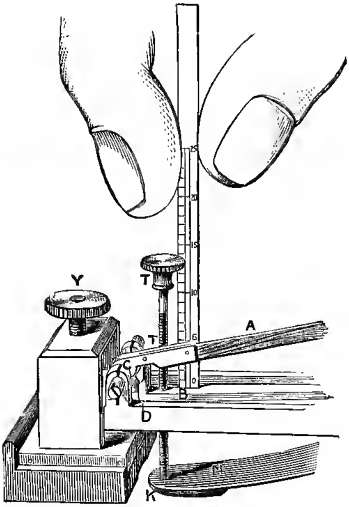


FIG. 209.—End view of the block by which the sphygmograph rests on the bones of the wrist, showing the screw, G, by which the pressure exercised by the spring on the artery can be varied (§ 39).

FIG. 209*b*.—Breguet's improvement (§ 39).

FIG. 210.—Mode of measuring pressure (§ 39).

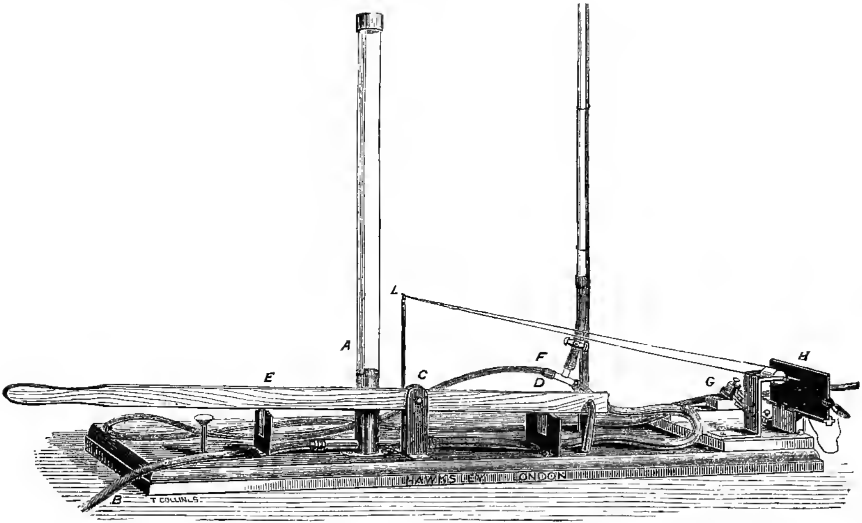
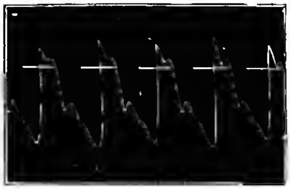


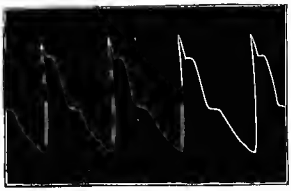
FIG. 211.—Schema for demonstrating the nature of the arterial movements. A. Glass tube which represents the heart. B. The tube by which A communicates with a cistern at a height of ten or twelve feet above it. (A much smaller head of water is sufficient.) C. The lever by which the two valves E and D are worked, the same act which shuts the one opening the other. F. Commencement of the experimental tube, which is of black vulcanite. At F the tube communicates with a long vertical tube of glass, only part of which is seen; it is closed at the top, and usually shut off from F by a pinchcock. At G the tube passes under the spring of the sphygmograph, the frame of which rests on a block (below G). By error, the tube has been drawn on the wrong side of the block. H. The blackened plate of the sphygmograph. To the left of it is seen the cylinder, with its needle for recording the time which intervenes between the opening and closing of the aortic valve, D. L. A rod which is firmly fixed in the lever, and is connected by two cords, one of which is elastic with the cylinder (§ 40).

PLATE LXXXVII.



a

FIG. 212*a*.—Tracings obtained with the arterial schema (§ 40).



b

FIG. 212*b*.—Natural pulse.

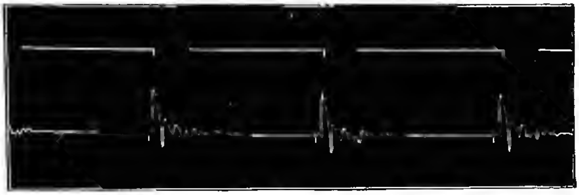


FIG. 213.—Percussion waves (§ 41.)

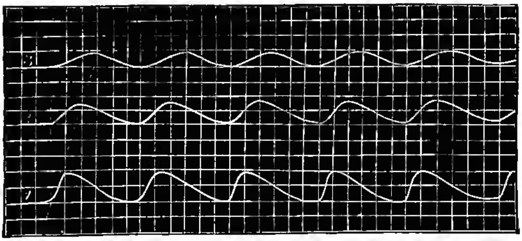


FIG. 214.—Tracings showing the contractions and expansions of an india-rubber tube, along which water is propelled in an intermitting stream by squeezing with the hand at regular intervals of time an elastic bag provided with valves, with which the tube is in communication; the bag thus represents the heart. The three tracings are drawn simultaneously, and exhibit the expansive movements of the tube at three different distances from the bag, the upper tracing being taken at the greatest distance (§ 41).

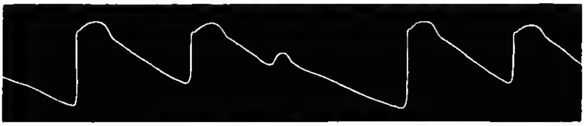


FIG. 215.—Sphygmographic tracing (§ 42).

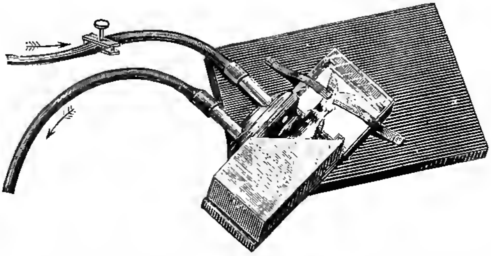


FIG. 216.—Dr. Caton's fish-trough (§ 44). It must be used with the microscope stage inclined at an angle of about 40°.

PLATE LXXXVIII

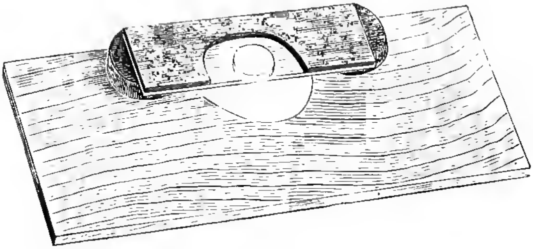


FIG. 217.—Stage for mesentery of frog (§ 44).

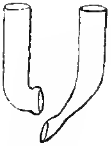


FIG. 218.—Cannulæ for aorta and *vena cava* of frog. The right-hand figure represents the arterial cannula. They are of size suitable for large specimens of *R. esculenta* (§ 46).

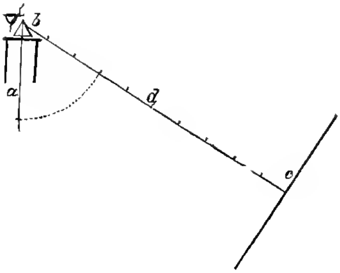


FIG. 219.—Diagram of arrangement for measuring objects seen under the microscope. *a*. Axis of tube of microscope. *b*. Prism. *d*. Direction in which the object is seen. *c*. Surface of drawing-board, which should be at a distance of 10 inches (25 centimeters) from the eye. The angles of the prism being equal, the angle *a b c* = 60° (§ 48).

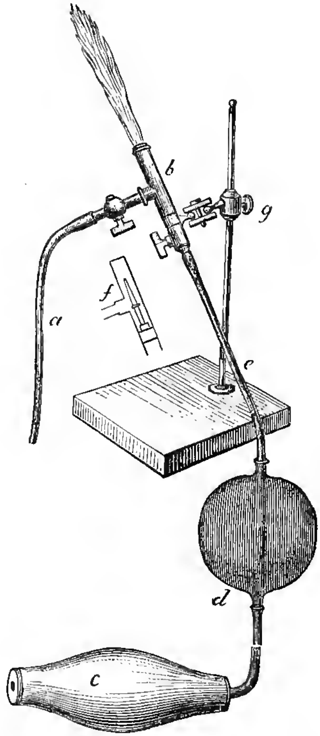


FIG. 221.—Griffin's blower and expanding regulator, as used for gas blow-pipe. The blower is used for artificial respiration (*see* § 49).

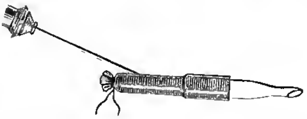
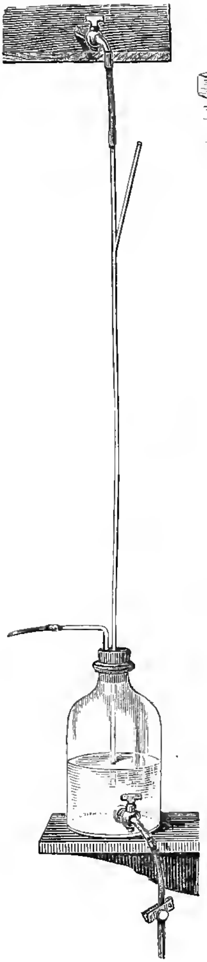


FIG. 220.—Cannula for injecting any liquid into a vein (§ 49).

PLATE LXXXIX.



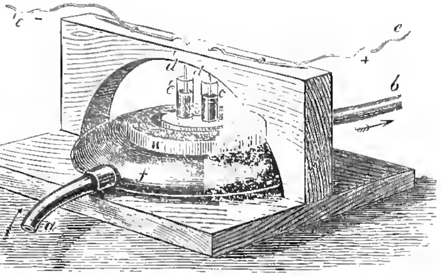


FIG. 223.—Mercurial breaker for artificial respiration (§ 49).

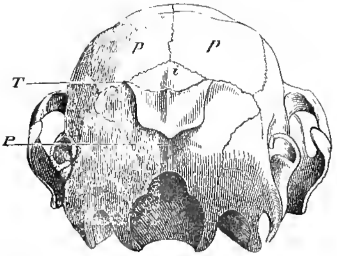
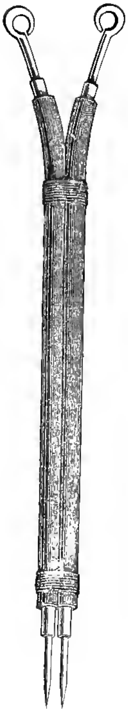


FIG. 224.—Skull of rabbit seen from behind. *p p*, Parietal bones; *i*, interparietal bone; below *i*, occipital tubercle; above P, occipital protuberance. Half-way between the tubercle and the protuberance is the point at which the bone must be perforated in the operation for producing glycosuria (§ 50).



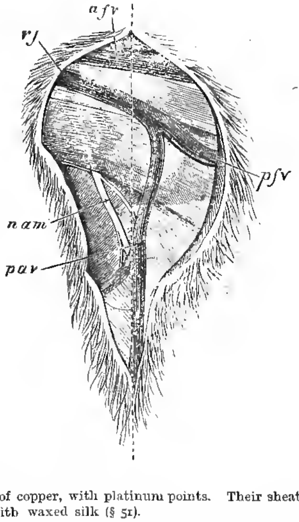


FIG. 222.—Sprengel's blower (§ 49).

FIG. 225.—Excitor. The wires are of copper, with platinum points. Their sheaths are made of bits of flexible catheter, and are bound together with waxed silk (§ 51).

FIG. 226.—Parts exposed in the rabbit by an incision extending from the thyroid cartilage to the root of the left ear. *vj*, Bifurcation of the jugular vein; *p f v*, posterior facial vein; *p a v*, posterior auricular vein; *a f v*, anterior facial vein; *n a m*, great auricular nerve, where it emerges at the posterior edge of the sterno-mastoid muscle (§ 53).

PLATE XC.

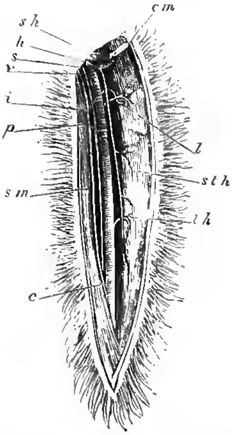


FIG. 227.—Carotid artery of rabbit, and parts in relation with it. *c*, Carotid; *c m*, *cornu majus* of hyoid bone; *s h*, stylohyoid muscle; *h*, hypoglossal nerve; *s*, sympathetic; *v*, vagus nerve; *i*, points to superior laryngeal nerve where, close to its origin from the vagus, it passes behind the carotid; *p*, pharyngeal artery; *s m*, edge of sterno-mastoid muscle; *t h*, thyroid artery; *s t h*, sterno-hyoid muscle; *l*, laryngeal artery the nerve which crosses it is the *descendens noni* (§ 56).

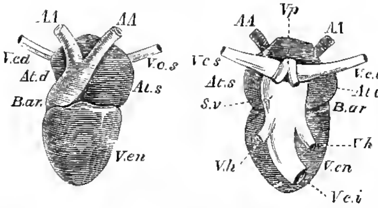
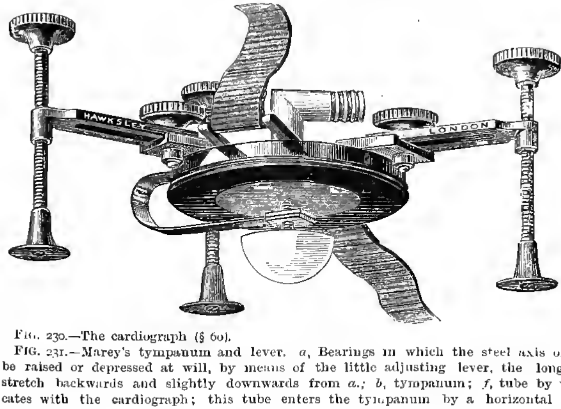


FIG. 228.—Heart of frog (after *Fritsche*); front view to the left, back view to the right. *A A*, Aortæ; *V.c.s.*, *venæ cavæ superiores*; *At.s*, left auricle; *At.d*, right auricle; *Ven.*, ventricle; *B.ar.*, *Bulbus arteriosus*; *S.v.*, *sinus venosus*; *V.c.i.*, *vena cava, inferior*; *V.h.*, *venæ hepaticæ*; *V.p.*, *venæ pulmonales* (§ 57).



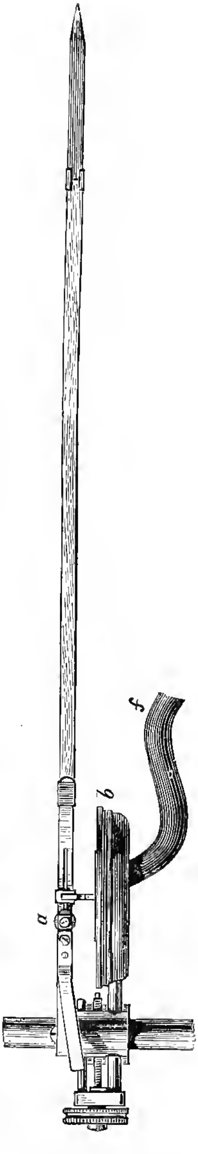


FIG. 230.—The cardiograph (§ 60).

FIG. 231.—Marey's tympanum and lever. *a*, Bearings in which the steel axis of the lever works; it can be raised or depressed at will, by means of the little adjusting lever, the long arm of which is seen to stretch backwards and slightly downwards from *a.*; *b*, tympanum; *f*, tube by which its cavity communicates with the cardiograph; this tube enters the tympanum by a horizontal metal tube on its further side.

PLATE XC.

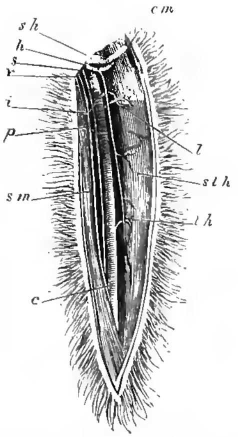


FIG. 227.—Carotid artery of rabbit, and parts in relation with it. *c*, Carotid; *c m*, *cornu majus* of hyoid bone; *s h*, stylohyoid muscle; *h*, hypoglossal nerve; *s*, sympathetic; *v*, vagus nerve; *i*, points to superior laryngeal nerve where, close to its origin from the vagus, it passes behind the carotid; *p*, pharyngeal artery; *s m*, edge of sterno-mastoid muscle; *t h*, thyroid artery; *s t h*, sterno-hyoid muscle; *l*, laryngeal artery the nerve which crosses it is the *descendens noni* (§ 56).

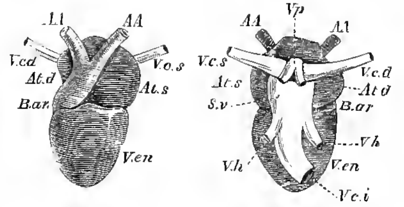
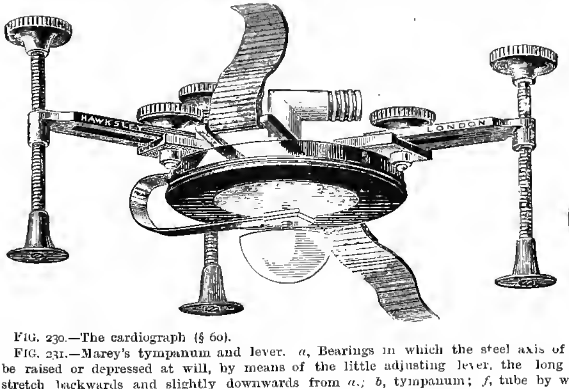


FIG. 228.—Heart of frog (after *Fritsche*); front view to the left, back view to the right. *A A*, Aortæ; *V.c.s.*, *venæ cavæ superiores*; *At.s*, left auricle; *At.d*, right auricle; *Ven.*, ventricle; *B.ar.*, *Bulbus arteriosus*; *S.v.*, *sinus venosus*; *V.c.i.*, *vena cava inferior*; *V.h.*, *venæ hepaticæ*; *V.p.*, *venæ pulmonales* (§ 57).



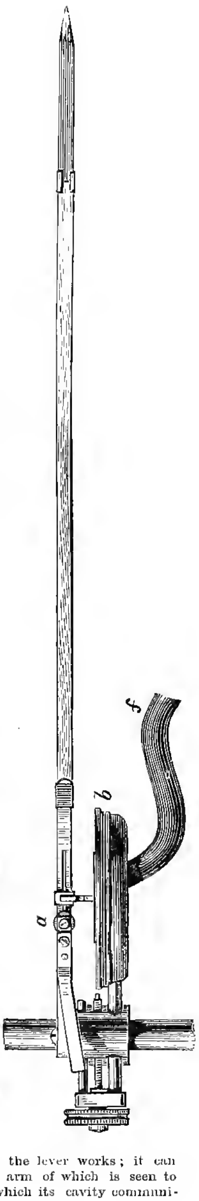


FIG. 230.—The cardiograph (§ 60).

FIG. 231.—Marey's tympanum and lever. *a*, Bearings in which the steel axis of the lever works; it can be raised or depressed at will, by means of the little adjusting lever, the long arm of which is seen to stretch backwards and slightly downwards from *a*.; *b*, tympanum; *f*, tube by which its cavity communicates with the cardiograph; this tube enters the tympanum by a horizontal metal tube on its further side.

PLATE XCI.

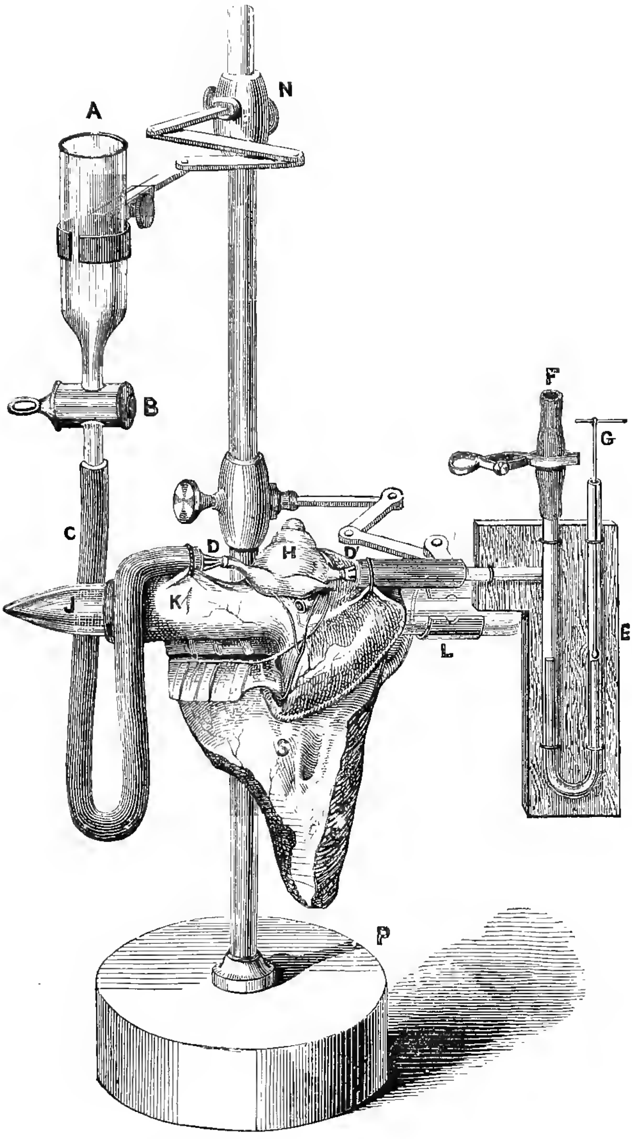
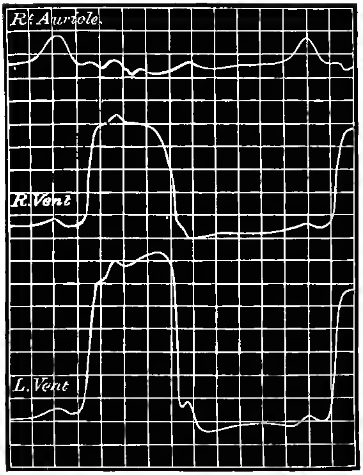


FIG. 233.—Coats' apparatus. A, Reservoir; B, stopcock; C, tube leading from reservoir to D, *vena cava inferior*; D′, aorta, the cannula in which is in communication with the manometer; F, tube guarded by clip, by which proximal end of manometer is closed; G, style, which records the movements of the distal column of the manometer on the cylinder; H, heart; K, ligature, by which the tube is secured to the distended œsophagus; L, holder, by which the glass rod J is supported (§ 63).

PLATE XCII.



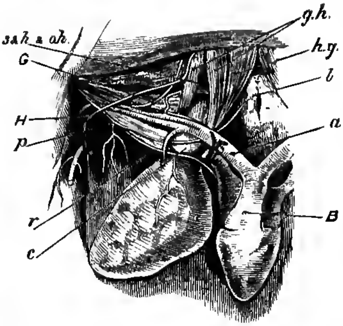


FIG. 237.—Dissection of the parts in relation with the vagus nerve of the frog on the right side. The œsophagus is distended with a glass tube about half an inch in width. The object is represented of about twice the actual size. *a*, Right aorta; B, *bulbus aortæ*; *c*, posterior horn of hyoid bone; *g.h.*, geniohyoid muscle; *h.g.*, hyoglossus muscle; *p*, lowest of the three petrohyoid muscles; H, ninth nerve; G, glossopharyngeal nerve; *r*, vagus; *b*, larynx; *s & h & oh.*, point to the space occupied by the origins of the large muscle (sternohyoid) which connects the hyoid with the sternum, as well as by the omohyoid; both of those muscles have been cut away (§ 73).

FIG. 235.—Tracings obtained by recording simultaneously on the same cylinder the variations of pressure in the right auricle, right ventricle, and left ventricle, respectively. The interval between each vertical line and the next corresponds to about a tenth of a second. The second vertical line is just before the completion of the systole of the auricles. The contraction of the ventricles falls between the third and fourth lines. It ends between the seventh and eighth; consequently, in the horse, the interval of time between the auricular systole and that of the ventricles is about 0·15 sec., and the duration of the ventricular systole is about 0·4 sec. (After Chauveau; *see* § 67.)

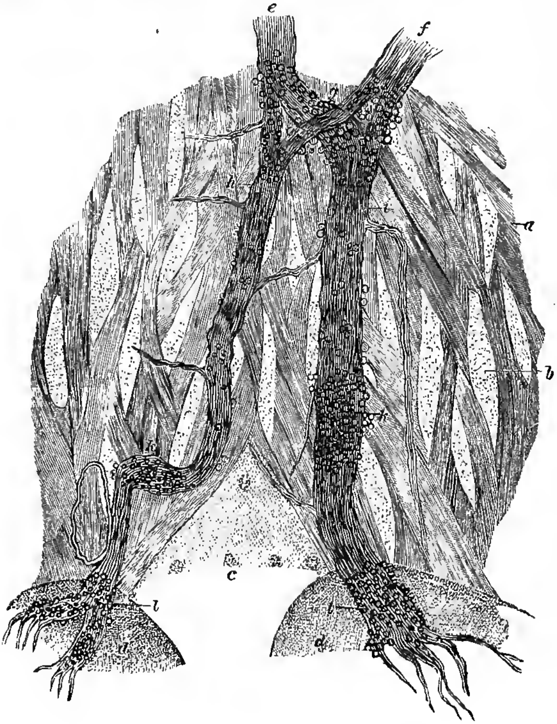
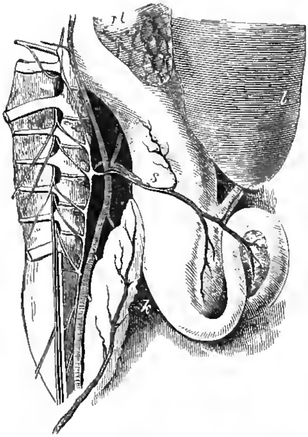
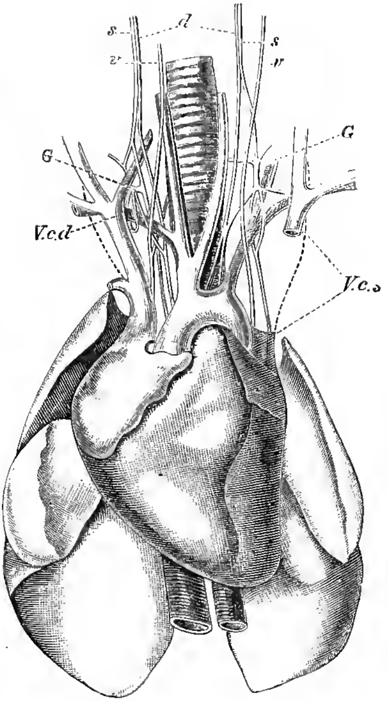


FIG. 236. — Septum auricularum of frog. *a*, Muscular fibres; *b*, endocardium; *c*, free edge of septum; *dd*, wall of ventricle; *e*, right cardiac branch of vagus; *f*, left branch; *h*, anterior nerve of septum; *i*, posterior nerve; *kk*, Bidder's ganglia; *ll*, ganglia of ventricle; § 69. (After Bidder.)

PLATE XCIII.





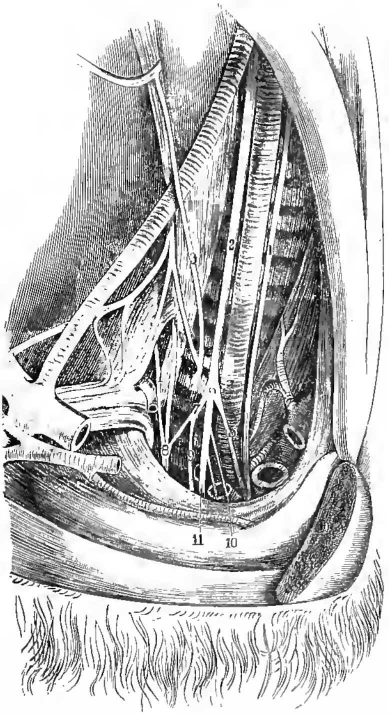


FIG. 240.—Sketch to illustrate the relations of the ganglionic cord in the visceral cavity of the frog. The *septum cisternæ magnæ* having been divided on the right side, the right kidney is turned over towards the left, so as to expose the parts concealed by it, viz., the aorta and the ganglionic cord of the same side. The stomach and the first coil of intestine are also turned over, so that the posterior surface of the former organ is presented. In this way the origin of the mesenteric artery from the junction of the right and left aortæ is brought into view. On its surface nervous filaments, which spring from the ganglionic cord, may be traced. These (*nervi mesenterici*) combine to form a plexus with similar filaments from the corresponding ganglion of the other side. (*See* fig. 295.) *l*, Liver; *r l*, right lung; *s*, stomach; *k*, kidney.

FIG. 241.—Heart, lungs, and great vessels of the rabbit, with the nerves in relation with them. (After Ludwig, slightly altered.) *V.c.d.*, *V.c.s.*, Right and left *venæ cavæ superiores*; the left *vena cava* is represented as if cut away, in order to show the nerves. *G*, *Ganglion cervicale inferius*; *s*, sympathetic; *v*, vagus; *d*, depressor. The dotted lines on each side indicate the position of the chrenic (§ 81).

FIG. 242.—Dissection of the lower cervical ganglion in the dog, and of the parts in relation with it. (After Schmiedeberg.) 1, Recurrent nerve; 2, common trunk of the vagus and sympathetic; 3, phrenic; 4 (leading upwards and to the right from 8), *ramus vertebralis*; 5, communicating branch between inferior cervical ganglion (6) and recurrent; 7, trunk of sympathetic; 8, first thoracic ganglion; 9, *ramus cardiacus superior*; 11, trunk of vagus (§ 81).

PLATE XCIV.

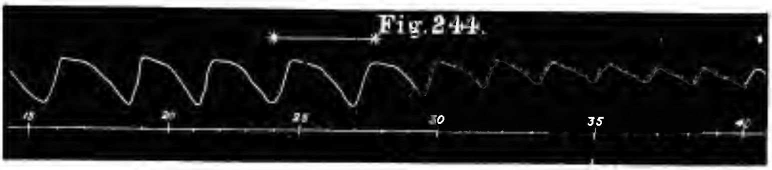


FIG. 244.—Tracing (after Schmiedeberg) showing the effect of electrical stimulation of the vagus of a frog under the influence of nicotin. The line ending in asterisks indicates the duration of the period of excitation (§ 81).

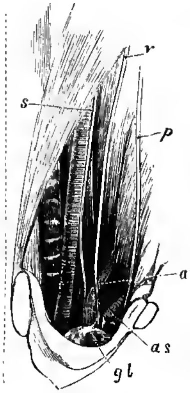
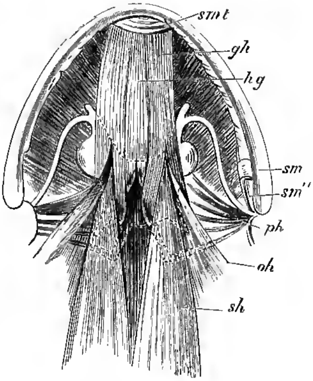


FIG. 243.—Dissection of inferior cervical ganglion of rabbit. The pectoral muscles and sterno-clavicular ligament have been divided, and other more superficial parts removed. The dotted line indicates the middle line of the body. *g l*, A lymphatic gland in contact with the apex of the lung; *a s*, sub-clavian artery; *a v*, vertebral artery; *v*, vagus nerve; *s*, sympathetic; *p*, phrenic (§ 81).

FIG. 246.—Respiratory muscles of frog (after Ecker), *smt*, submentalis; *g h*, geniohyoideus; *h g*, hyoglossus; *s m*, submaxillaris; *s m″*, anterior horn of the hyoid bone; *p h*, petrohyoidei; *o h*, omohyoideus; *s h*, sternohyoideus.



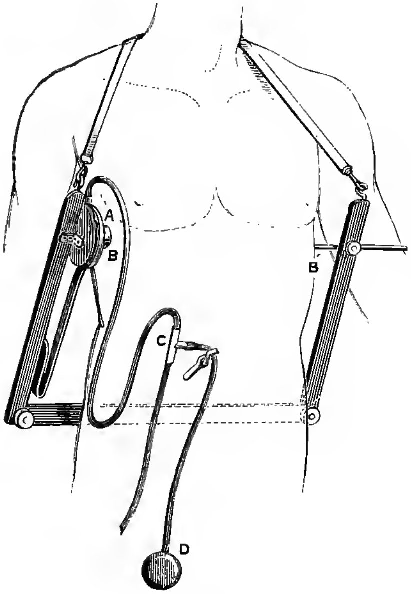
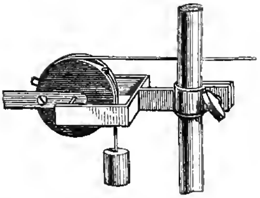


FIG. 247.—Recording Stethometer. A, Tympanum; B, ivory knob; B′ rod which carries the knob opposed to B. C, T-tube, by which A communicates, on the one hand with the recording tympanum, on the other with an elastic bag D. The purpose of the bag is to enable the observer to vary the quantity of air in the cavity of the tympana at will. The tube leading to it is closed by a clip when the instrument is in use. (§ 89).

PLATE XCV.



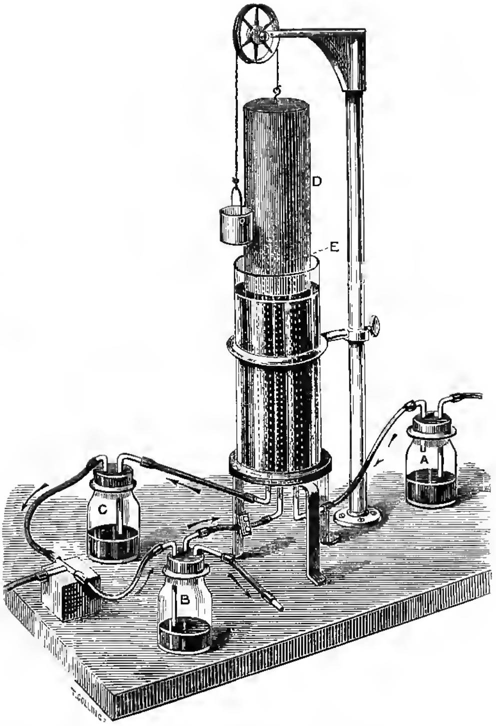


FIG. 250.—Boxwood Pulley for recording the movements of a needle, inserted in the diaphragm. A light lever is attached to the horizontal arm (§ 91).

FIG. 251.—Bosenthal's apparatus, with W. Müller's valves (§ 96).

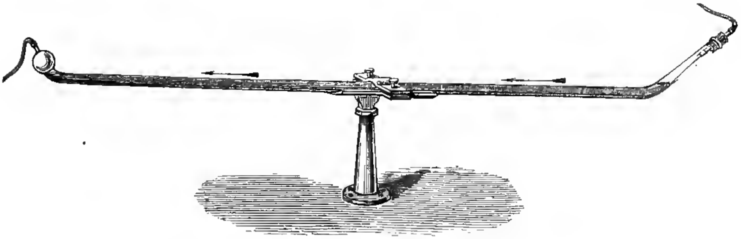


FIG. 252.—Pettenkofer's Tube, for the absorption of carbonic acid gas (§ 98).

PLATE XCVI.

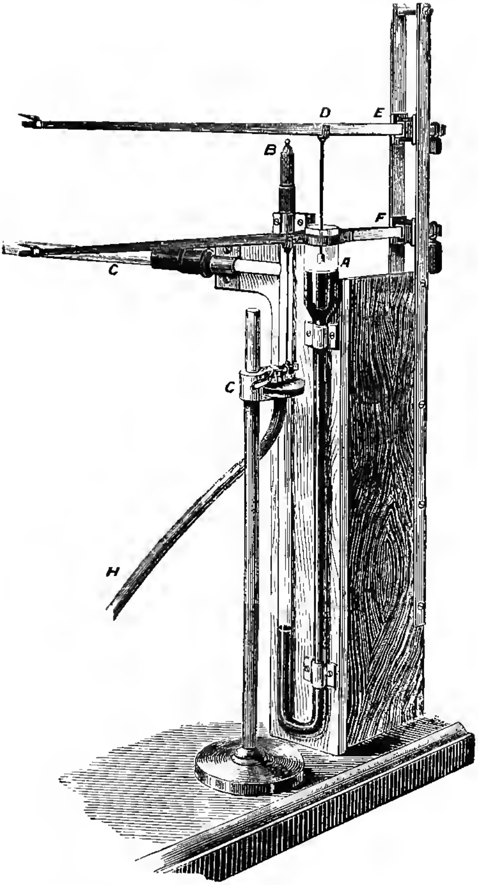


FIG. 257.—The lever kymograph, for recording the respiratory and arterial movements simultaneously (§ 105).

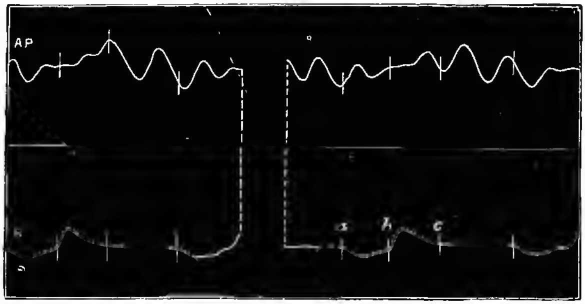


FIG. 258.—Tracing obtained with the lever kymograph (§ 105).

PLATE XCVII.

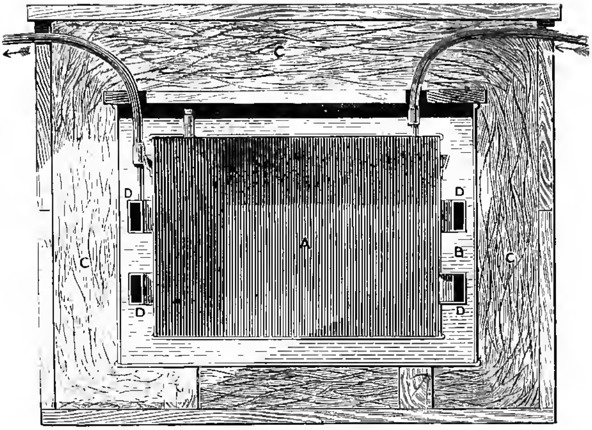
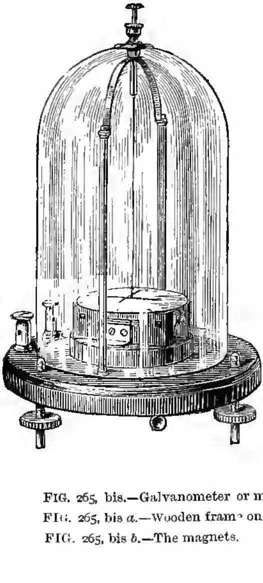
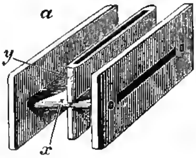


FIG. 265.—The calorimeter (§ 116).





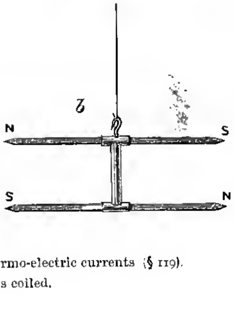


FIG. 265, bis.—Galvanometer or multiplier, for thermo-electric currents (§ 119).

FIG. 265, bis *a*.—Wooden frame on which the wire is coiled.

FIG. 265, bis *b*.—The magnets.

EXPLANATION OF PLATES XCVIII. TO CI.

FIG. 229.—Tracing drawn by a lever applied directly to the apex of the heart of the frog.

FIG. 234.—Tracing of endocardial pressure of heart of frog, obtained by Coats' method.

FIGS. 238 *a* and *b*.—Synchronous tracings of arterial pressure, and respiratory movement of air in trachea, taken (*a*) immediately before, and (*b*) one minute after, section of both vagi. The lever kymograph (fig. 257) was employed. Arterial pressure before section about 150 m.m., after section about 180 m.m. Pulse rate before section 110, after section 260. Respirations before section 24, after section 10. The characteristic violence of the expiratory movements after section is well shown.

FIG. 239.—*a*. Tracing of arterial pressure of rabbit, obtained with Fick's kymograph (fig. 205) during excitation of peripheral end of divided vagus, with feeble induced currents (secondary coil far removed from primary). Duration of excitation of nerve indicated by asterisks. *b*. The same, with secondary coil brought nearer.

FIG. 245.—Tracing of arterial pressure with Fick's kymograph during excitation of the central end of the depressor nerve (§ 82).

FIG. 232.—*a*. Tracing obtained with the cardiograph, when the button is applied to the seat of impulse of the human heart. *b*. Tracing obtained when the button is applied either outside of the impulse or nearer the sternum. The line of sudden descent in *b* coincides with that of sudden ascent in *a*. Both are coincident with the sudden hardening of the ventricle, *i.e.*, with the complete closure of the mitral and tricuspid valves (§ 60).

FIG. 246 bis.—Tracing of respiration of frog (§ 86).

FIG. 249.—Tracing of intrathoracic pressure (§ 90).

FIG. 248.—Tracing obtained with the stethometer when applied as in fig. 247. *i*, Inspiration; *e*, expiration. Immediately after *a*, a notch in each of the curves occurs, the descending limb of which expresses the moment of cardiac impulse. Compare fig. 232*b* (§ 89).

FIG. 253.—Respiration of the cat before and after section of both vagi. The tracing expresses the variations of pressure which occur in the air passages during each respiratory act. In *b* the horizontal line is that drawn by the lever when at rest; consequently, when the pressure in the air passages is less than that of the atmosphere the lever rises, when it is greater it falls. The sudden expiratory movement which is the most marked characteristic of the mode of breathing after section of both nerves commences at *e* (§ 92).

FIG. 263*a*.—Tracing of arterial pressure and respiratory movements in the second stage of asphyxia by occlusion. *a p*, Arterial pressure; *i*, respiration. Both tracings express the movements of mercurial manometers (§ 109).

FIG. 263*b*.—Slow asphyxia. The lower tracing expresses the movements of an elastic bag in communication with the trachea (§ 110).

FIGS. 259-261.—Tracings of respiratory movements of the dog before and after curarization (§ 105).

FIG. 262.—Tracings of artificial respiration and arterial pressure, showing Traube's curves, as seen with vagi intact (§ 106).

FIG. 264.—Effect of a single injection of air in a curarized dog, after long discontinuance of artificial respiration (§ 111).

FIGS. 254 and 255.—Excitation of the central end of the vagus in the rabbit (§§ 102 and 103).

FIG. 256.—Excitation of the central end of the superior laryngeal nerve (§ 194).

PLATE 98.

Fig. 229

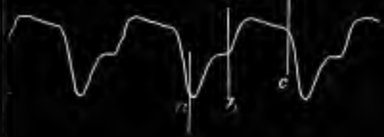


Fig. 231.

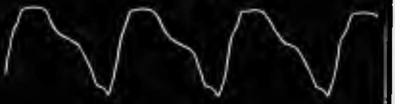


Fig. 238 a

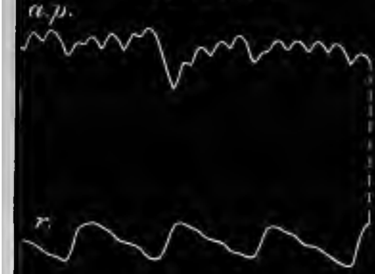


Fig. 238 b.

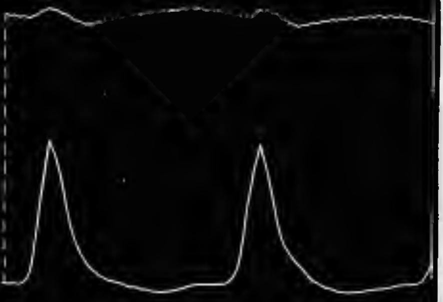


Fig. 239 a

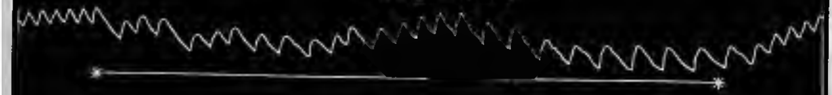


Fig. 239 b

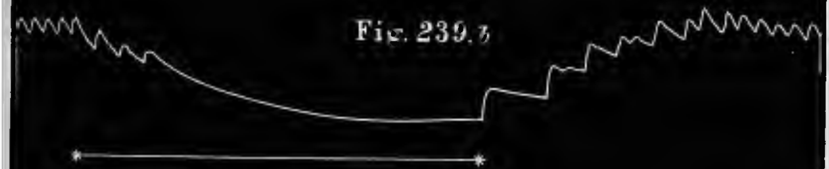


Fig. 245.

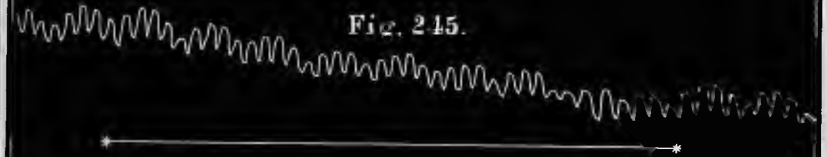


Fig. 232 a

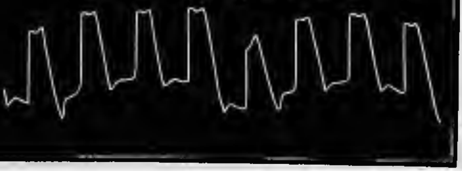


Fig. 232 b

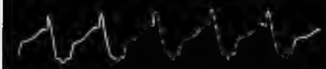


PLATE 99.

Fig. 246, bis.

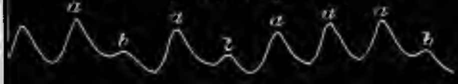


Fig. 249

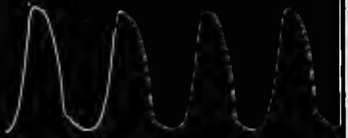


Fig. 248

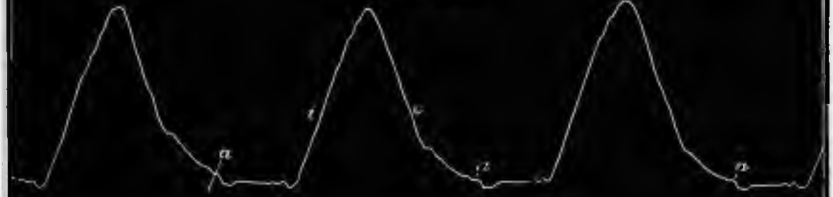


Fig. 253

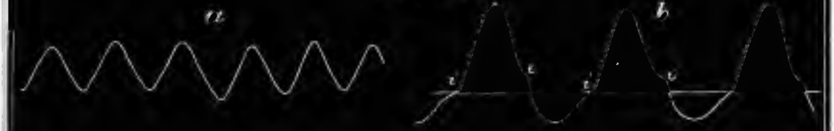


Fig. 263 b

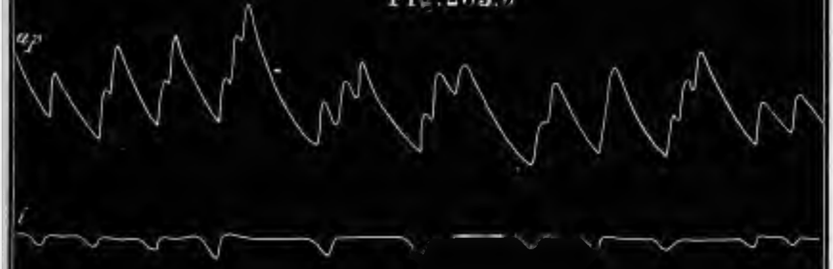


Fig. 263 a

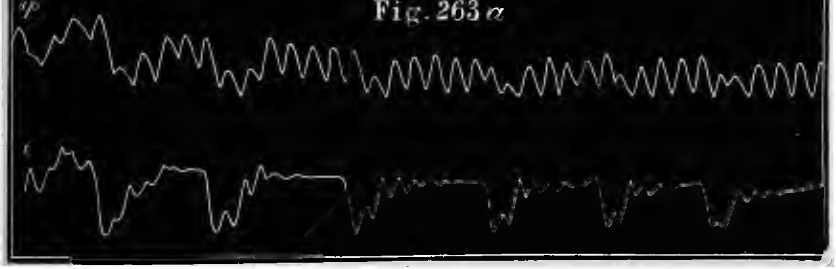


PLATE 100.

Fig. 259.

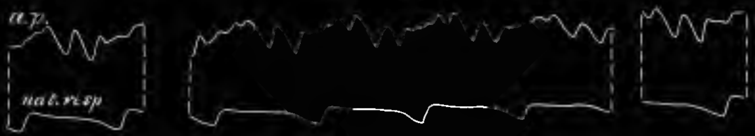


Fig. 260.

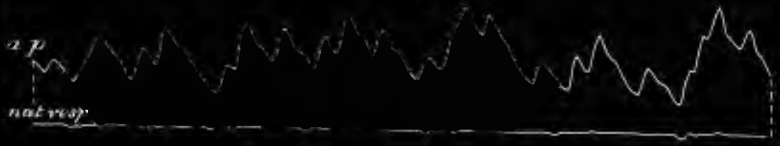


Fig. 261.

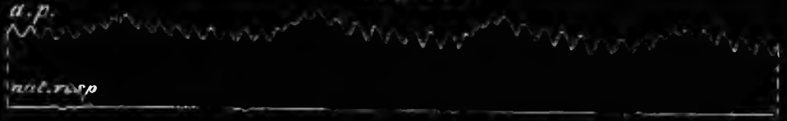


Fig. 262.

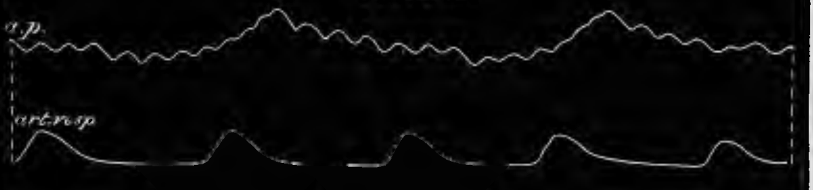


Fig. 264.

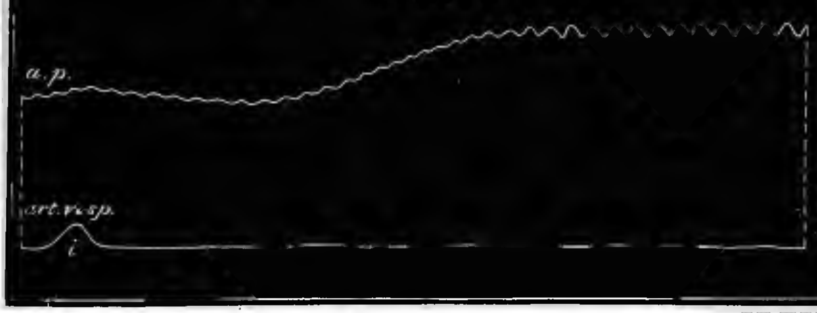


PLATE. 101.

Fig. 254.a

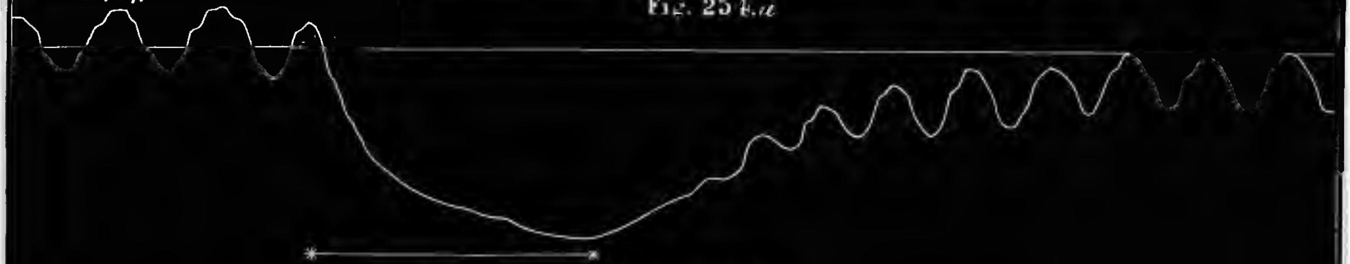


Fig. 254.z

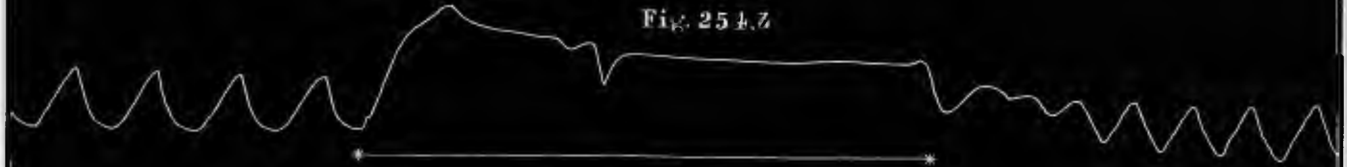


Fig. 255.

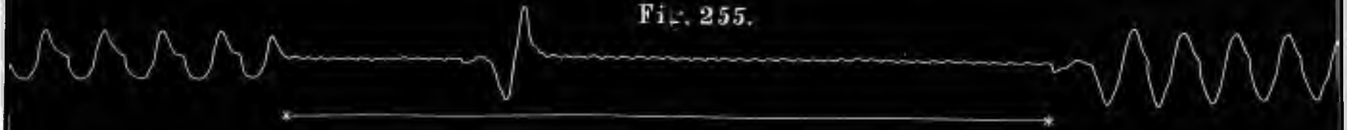


Fig. 256.

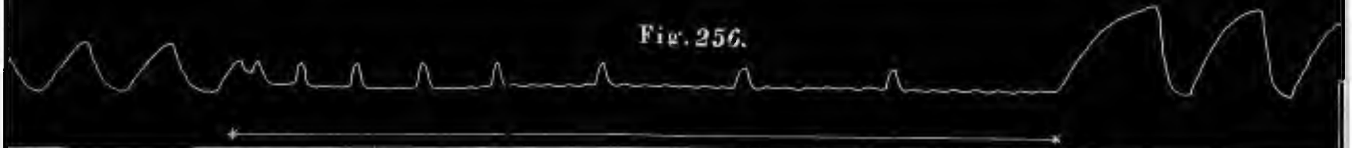
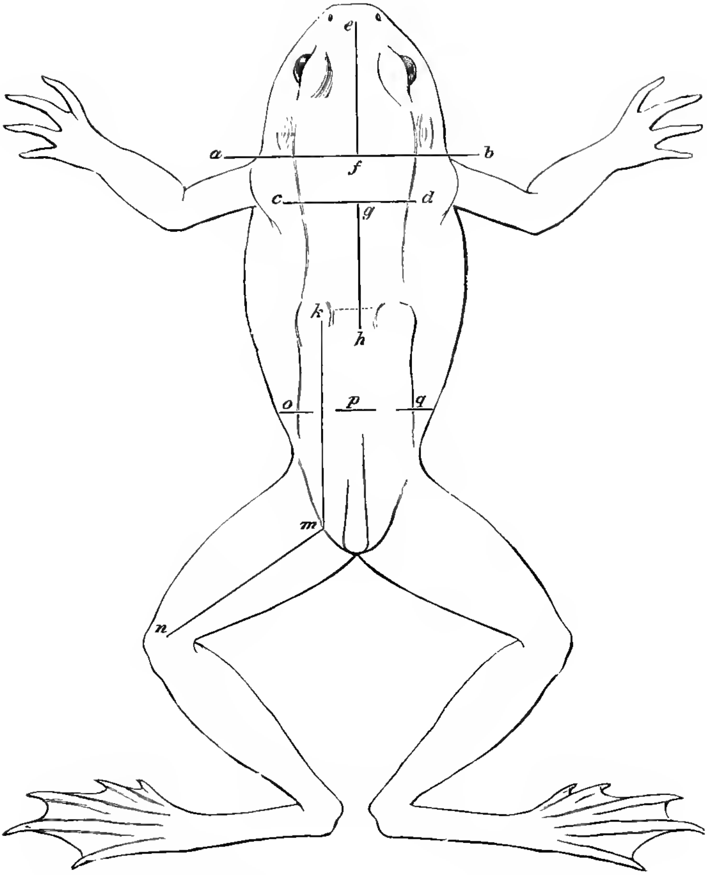


PLATE CII.



266.—Diagram of a frog, to show the lines of incision necessary in various observations.

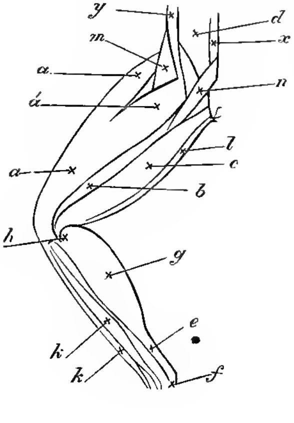


FIG. 267.—Diagram of the muscles of the leg of a frog, posterior surface. *a*, triceps femoris; *b*, biceps femoris; c, semi-membranosus; *d*, coccygeo-iliacus; *e f*, tendo achillis; *g*, gastrocnemius; *h*, head of gastrocnemius; *k*, peroneus (the muscle also marked *k* in front of and partly hidden by the preceding is the tibialis anticus); *l*, rectus internus; *m*, glutæus; *n*, pyriformis; *r*, coccyx; *y*, ilium; *a'*, vastus externus.

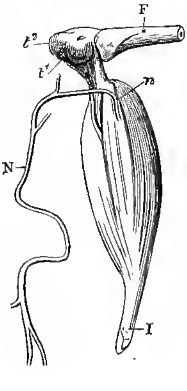


FIG. 268.—The nerve-muscle preparation. F, end of femur; N, sciatic nerve; I, tendo achillis; *t'*, attachment of smaller tendon of gastrocnemius to femur.

Plate CIII.

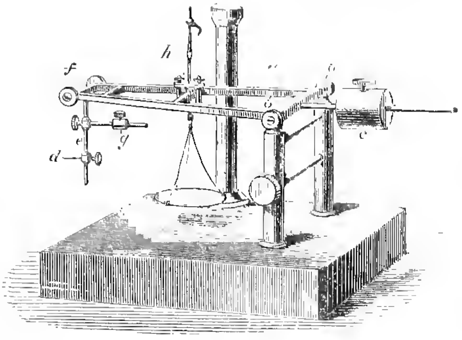


FIG. 269.—Myographion of Pflüger. The moist chamber, which is supported by the large pillar, and from which the thread *h* descends, is not shown. The lever *a* moves freely on the two pillars *b b*. At *f* the rod *e*, bearing the movable style *d*, with its movable counterpoise *g*, swings easily. At the opposite end of the lever is the heavy counterpoise *c*. The milled head on the side of one of the pillars *b* rotates the lower of the two bars connecting *b* and *b*. A silk thread is carried from *e* to this bar. By turning the milled head the style may thus be allowed to fall upon or remove away from the recording surface as desired

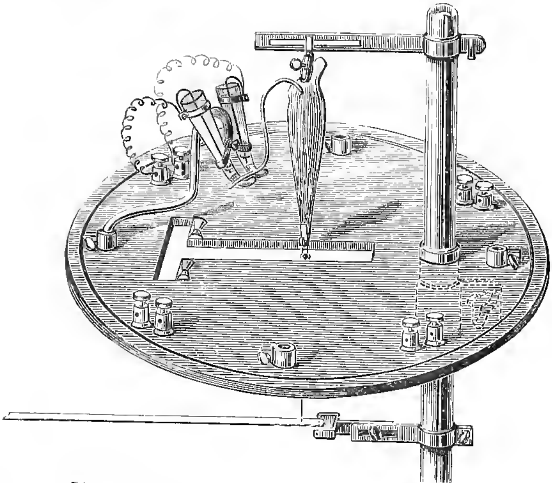


FIG. 270.—The moist chamber, with the nerve-muscle preparation, non-polarizable electrodes, electrode-bearer, and lever in position ready for an observation. The glass cover is not shown.

FIG. 270 *bis.* — Simple spring myograph of Marey, arranged horizontally. (*See* ch. xix.)

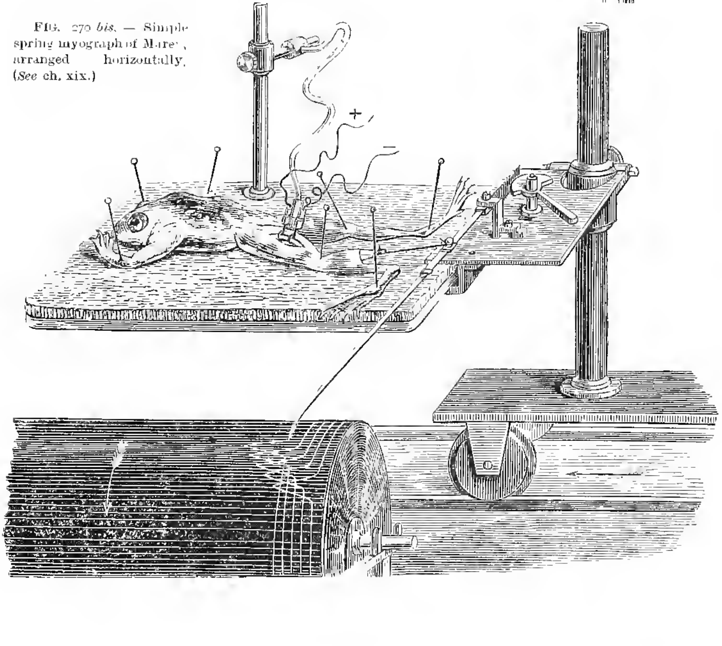
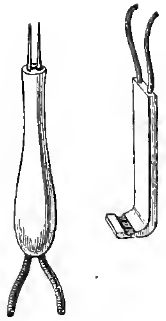


PLATE CIV.



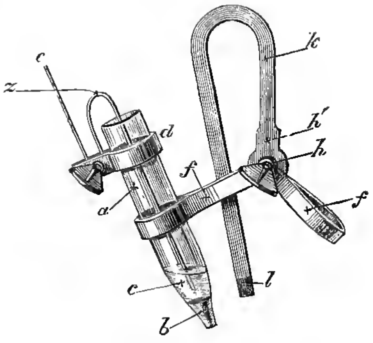
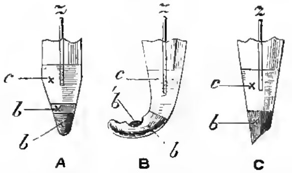


FIG. 271.—Ordinary electrodes. The pair on the right hand being the pair spoken of in the text as curved and shielded.
FIG. 272.—A non-polarizable electrode in the bearer.



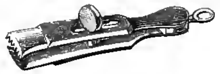


FIG. 273.—Ends of non-polarizable electrodes. A, with the clay plug *b* projecting beyond the glass tube; B, with the end of the glass tube closed and bent, a hole being drilled in the tube at *b'*, to expose the plug; C, oblique end with the clay plug flush with the glass tube.
FIG. 274.—Kronecker's forceps.

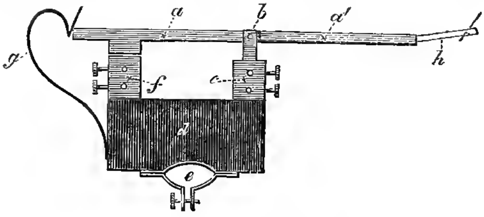


FIG. 275.—The marking lever

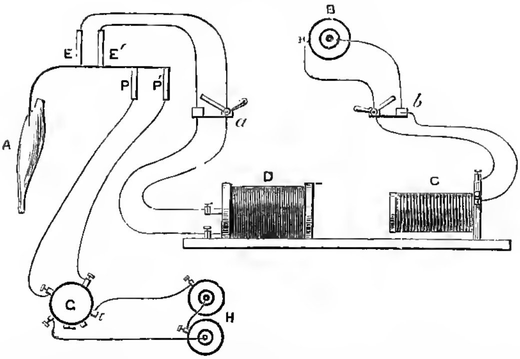


FIG. 276.—Diagram of the arrangement of apparatus for studying the effects of electrotonus or irritability. A, the muscle on whose nerve are placed (1) the polarizing electrodes PP', connected by the commutator C with the two celled battery H; (2), the exciting electrodes E E', connected through the Du Bois' key *a* with the secondary coil D. C, the primary coil, connected through the key *b* with the cell B.

PLATE CV.

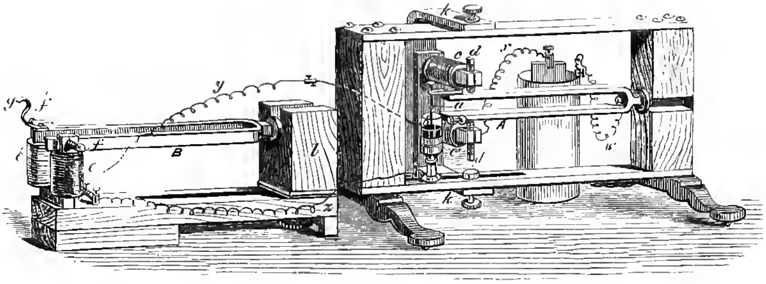


FIG. 277.—The recording tuning fork.

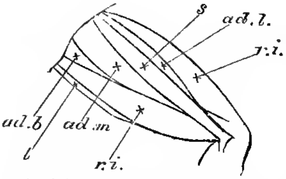


FIG. 278.—Diagram of the muscles of the thigh of a frog, anterior surface. *s*, sartorius; *ad.m.*, adductor magnus; *r.i.*, rectus internus major; *v. i.*, vastus internus, *ad. l.*, adductor longus; *ad. b.*, adductor brevis; *t*, rectus internus minor.

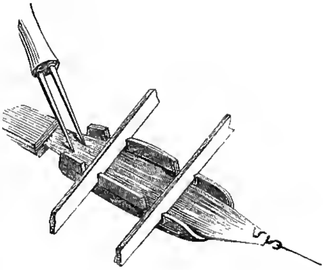


FIG. 280.—Muscle in a trough bearing two levers, in order to show the wave of muscular contraction. To the left are seen the pointed electrodes and the clamp fastening the muscle. At the other end of the muscle is the thread connected with the lever.

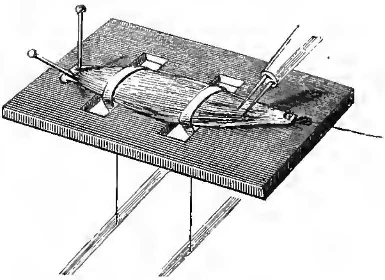


FIG. 281.—A different disposition of the levers, intended to show the same thing. The levers seen below the platform on to which the muscle is fastened, are connected with slips which pass round the muscle at different parts of its length.

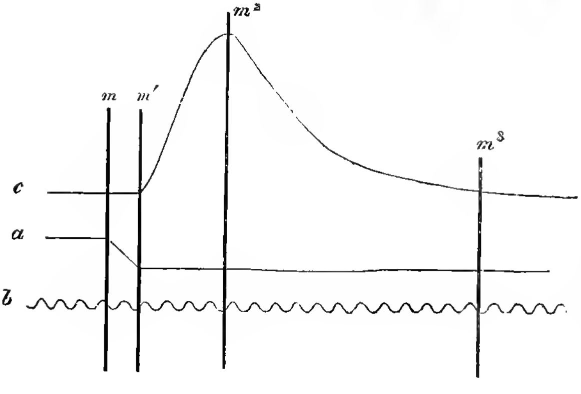


FIG. 279.—Diagram of a muscle curve as drawn on a travelling surface. *c*, the line described by the point of the lever connected with the muscle; *a*, the line described by marking lever; *b*, the line described by the tuning-fork. The vertical line *m* marks the moment of stimulation, *m'* the beginning, *m* 2 the maximum, and *m* 3 the end of the contraction of the muscle.

PLATE CVI.

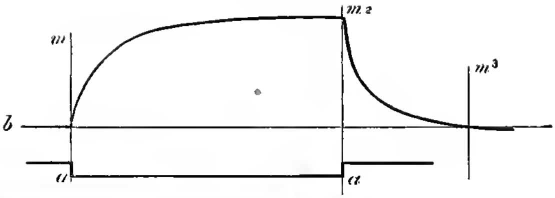


FIG. 282.—Diagram of the curve of tetanus. *b*, the line drawn by the point of the lever connected with the muscle; *a*, the line of the marking lever. The recording surface is supposed to be moving slowly. The line *m* marks the commencement of stimulation, and also of the contraction (the movement not being sufficiently rapid to show the latent period); *m2*, the cessation of stimulation and the commencement of relaxation; *m3*, the return of the muscle to its former length. The straight line, which is the continuation of *b* from *m* to *m3*, is the line which would have been described by the muscle in the absence of all contraction.

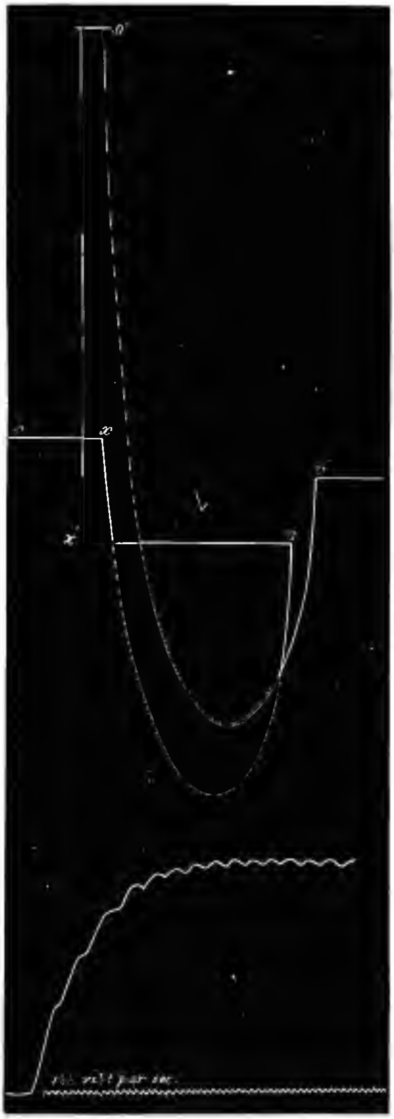


FIG. 283.—Lower part of large figure. Curve of tetanus, showing the individual contractions. Below are seen the vibrations of a recording tuning-fork.

FIG. 284.—Upper part of large figure. Curves illustrating the increased extensibility of a muscle during tetanus.

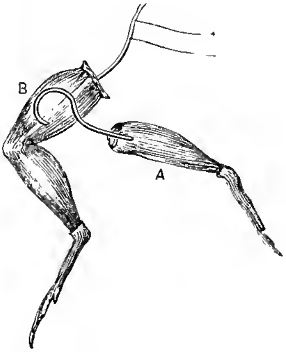


FIG. 285.—Muscles and nerves of frog, arranged for the experiment of the "rheoscopic frog."

PLATE CVII.

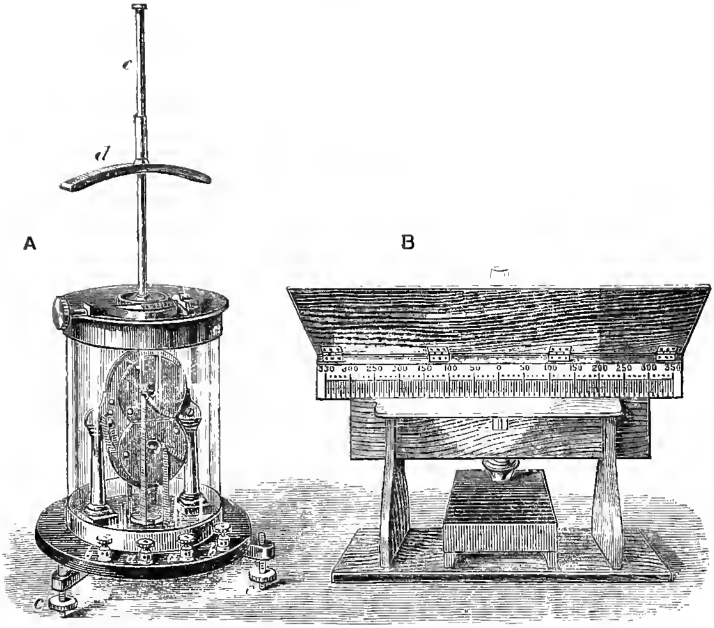


FIG. 286.—Sir W. Thomson's galvanometer and scale.

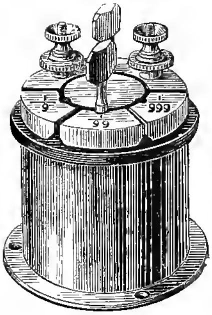


FIG. 287.—The shunt of the galvanometer.

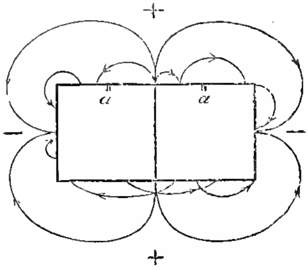
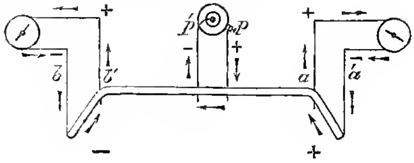


FIG. 288.—Diagram illustrating the "natural" current in a piece of muscle. The equator is marked by the positive sign, and the mid-points of the transverse sections by the negative. The arrows denote the direction of the current through the galvanometer. The larger curves denote the stronger currents, and *vice versâ*. *aa*, are two points on the longitudinal surface equidistant from the equator; between them, therefore, there is no current.



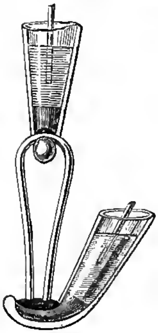


FIG. 289.—Arrangement of a nerve on non-polarizable electrodes in a way best suited for the demonstration of the natural currents in a nerve.

FIG. 290.—Diagram illustrating electrotonus. *p' p*, the polarizing electrodes; *aa'*, *b b'*, electrodes so placed as to show the effects of the natural current on a galvanometer at each end of the nerve when the polarizing current is in the direction of the arrows in the figure; the natural current of *a a'* is increased, as shown by the positive sign, while that of *b b'* is decreased, as shown by the negative sign.

PLATE CVIII.

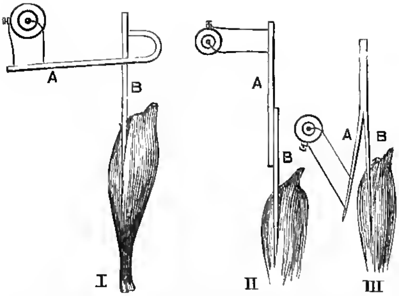


FIG. 291.—Diagram of a muscle and nerves, arranged to show the use of the electrotonic change in one nerve, A, as a stimulus for another, B. I. II. two different modes of placing the nerve of A on B; III. the so-called "paradoxical contraction."

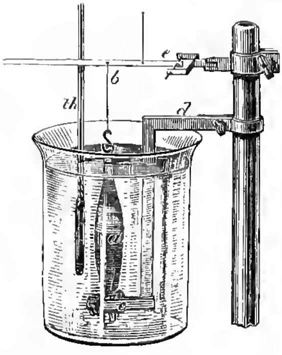


FIG. 292.—Apparatus for showing the effects of varying temperatures on a muscle.

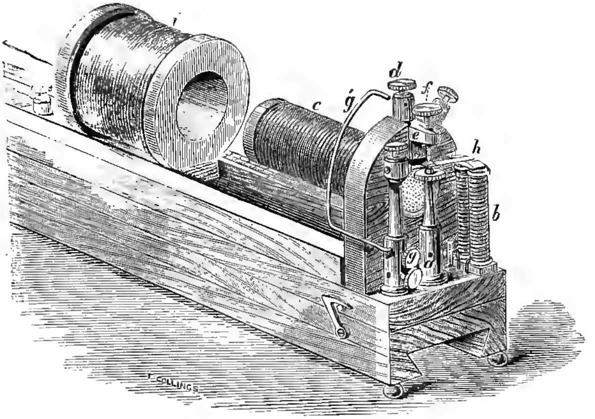


FIG 293.—The induction apparatus of Du Bois Reymond, with the magnetic interruptor.

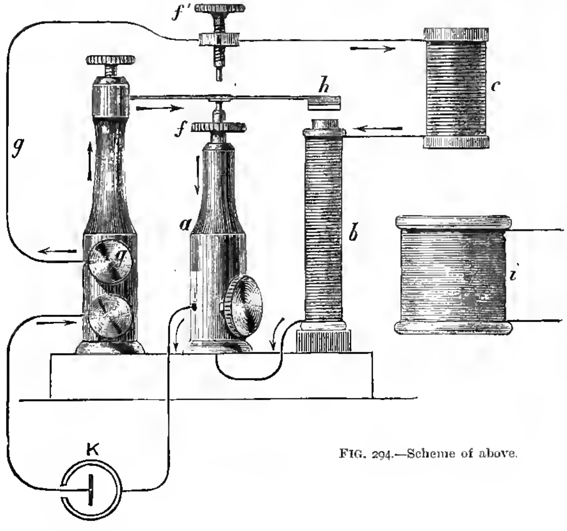
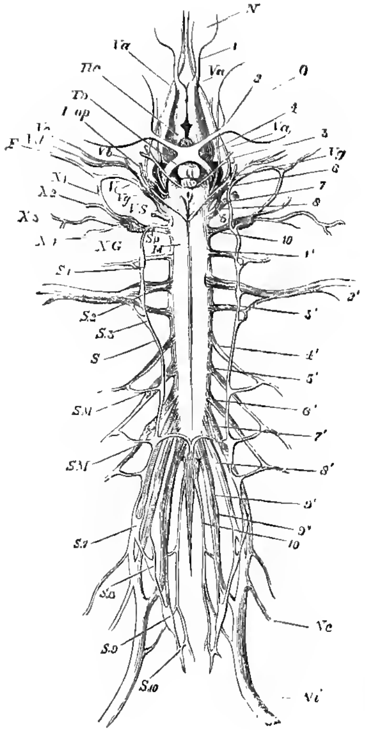
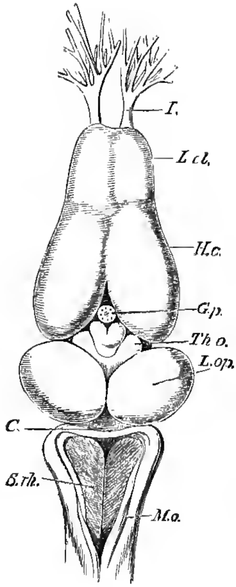


FIG. 294.—Scheme of above.

PLATE CIX.





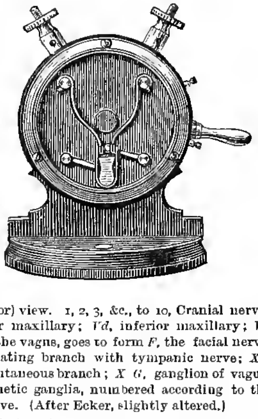
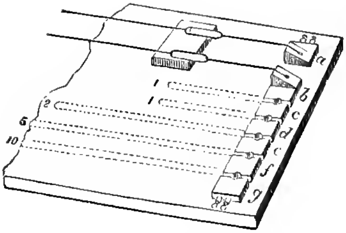


FIG. 295.—Diagram of the nervous system of a frog—anterior (or inferior) view. 1, 2, 3, &c., to 10, Cranial nerves in order. *Va*, ophthalmic branch; *Vb*, palatine nerve; *Vc*, superior maxillary; *Vd*, inferior maxillary; *Ve* tympanic nerve, which, after joining with the *ramus communicans* of the vagus, goes to form *F*, the facial nerve. *Vg*, ganglion gasserii. *X* 1—4, branches of tenth pair; *X* 1, communicating branch with tympanic nerve; *X* 2 glossopharyngeal nerve; *X* 3, nerves to stomach and intestines; *X* 4, cutaneous branch; *X G*, ganglion of vagus *M*, spinal cord; 1′ to 10′, spinal nerves in order; *S* 1 to *S* 10, sympathetic ganglia, numbered according to the nerves with which they communicate; *Nc*, crural nerve; *Ni*, sciatic nerve. (After Ecker, slightly altered.)

FIG. 296.—View of the brain of a frog from above, enlarged. *L.ol.* olfactory lobes; *H.c.* cerebral hemispheres, *G.p.* pineal body; *Th.o.* optic thalami; *L.op.* optic lobes; *C.* cerebellum; *M.o.* Medulla oblongata; *S.rh.* sinus rhomboidalis.

FIG. 297.—Commutator.

PLATE CX.



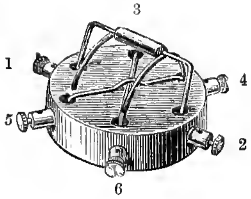


FIG. 298.—The Rheochord. The diagram represents the end of the board on which the resistance wires are stretched. *a, b, c, d, e, f, g,* are brass blocks which would, if it were not for the wires, be insulated. From the block *b* a german silver wire (the course of which is indicated by the dotted line), after turning round an ivory pin at 1, returns to *c*. From *c* a similar wire of exactly the same length returns to *d*. From *d* a wire three times the length returns to *e*; *e* and *f* are connected by a wire five times as long. From each of the blocks *a* and *b* platinum wires extend to the further end of the board, a distance of more than a metre, which are insulated at their extremities. They are, however, in metallic connection by means of a slide ("travelling mercury cups") shown in the diagram. According to the distance of the slide from *a* and *b*, which can be measured by a scale on the board, the resistance between *a* and *b* can be varied. When the slide is as far as it will go, the resistance is equal to that between *b* and *c*, or *c* and *d*. When the slide is pushed up to *a b*, the total resistance of the rheochord is twenty times as great as between *b* and *c*. If plugs (not shown in the diagram) are inserted between each block and its neighbour, the resistance is nil. (*See* p. 347.)

FIG. 299.—Double key.

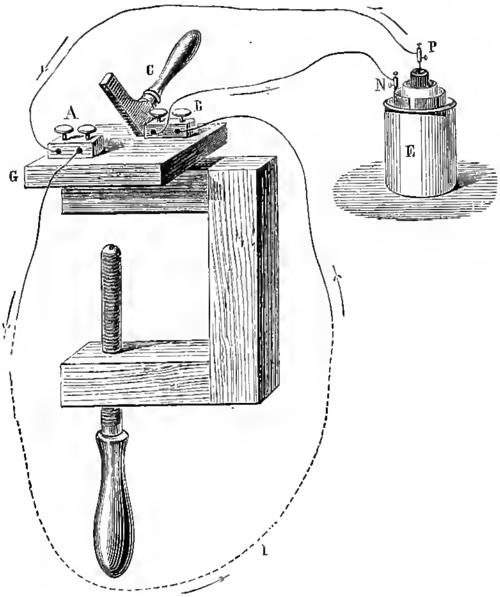


FIG. 300.—Du Bois Reymond's key.

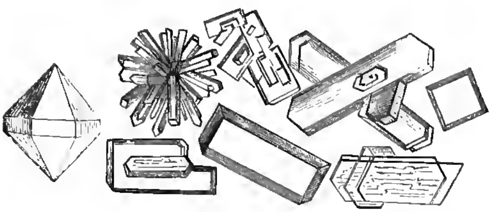


FIG. 301.—Creatine.

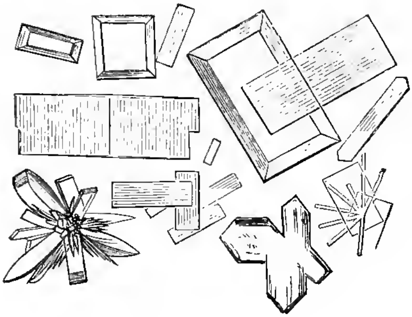


FIG. 302.—Creatinine.

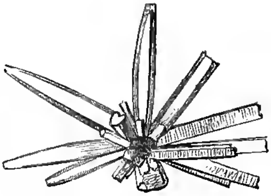


FIG. 303.—Nitrate of hypoxanthine.

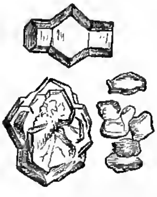


FIG. 304.—Hydrochlorate of xanthine.

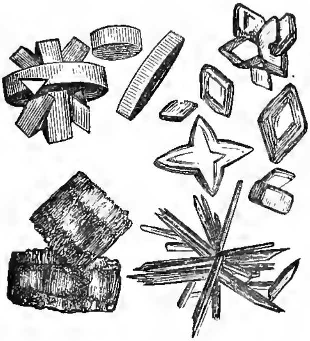


FIG. 305.—Uric acid.

PLATE CXII.

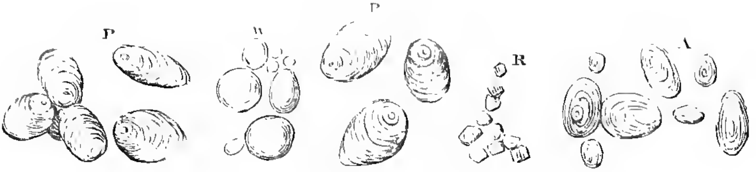


FIG. 306.—P, potato starch; W, wheat starch; R, rice starch; A, arrowroot starch.

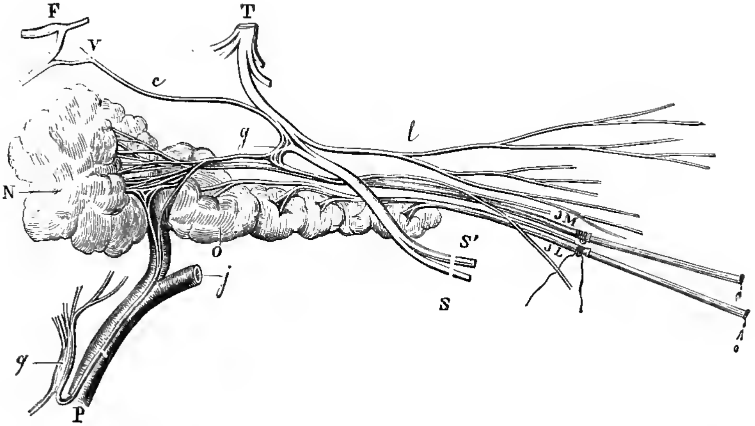


FIG. 307.—After Bernard. Nerves of the submaxillary and sublingual glands of the dog. N. Submaxillary Gland. O. Sublingual gland. J M. Wharton's duct, in which a cannula has been placed. J L. Duct of the sublingual gland, also furnished with a cannula. T, S, S′. The lingual branch of the fifth nerve. F. The facial nerve. *c.* Chorda tympani. *g.* The submaxillary ganglion. *q.* The superior cervical ganglion. P. Sympathetic twig passing from the ganglion to the submaxillary gland. *j.* Internal maxillary artery. V. Vidian nerve. *l.* Branch of the lingual nerve ramifying in the breccal mucous membrane.

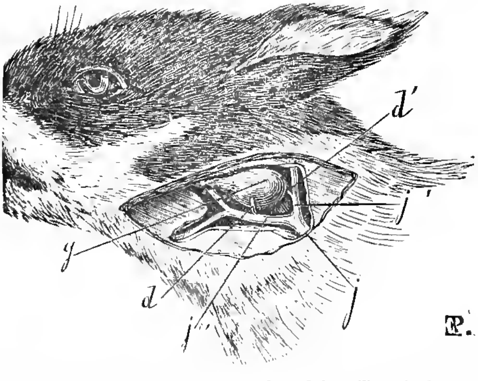


FIG. 308.—After Bernard. Veins of the submaxillary gland. *g.* Submaxillary gland. *j.* Jugular vein, dividing into two branches, *j′* and *j″*, which pass along the borders of the gland. *d.* Anterior vein, and *d′* posterior vein, from the gland.

Plate CXIII

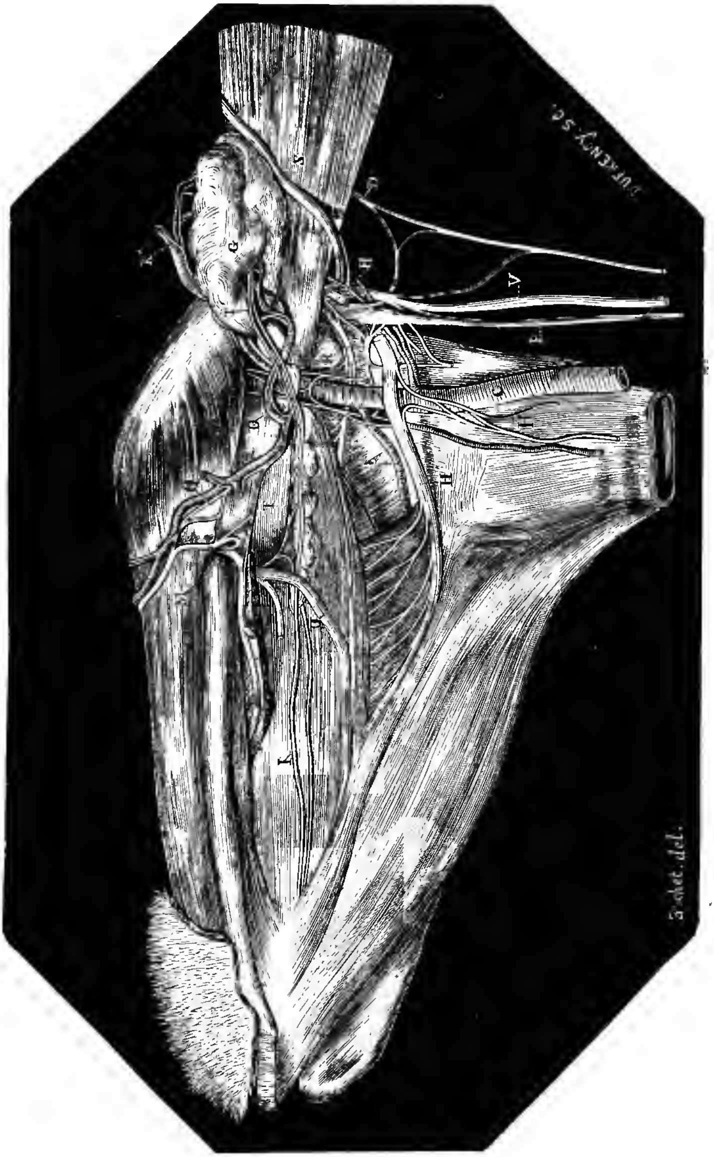


FIG. 309.—After Bernard. Dissection of the nerves of the submaxillary gland in the dog. *G.* Submaxillary gland, from which issues the duct K, accompanied at first by the lobules of the sublingual gland, which farther on has a separate duct. C. Common carotid artery. L. Lingual artery. O. Artery of the gland. It springs from the facial artery near its origin from the external carotid. H H′. The hypoglossal nerve, cut across to expose the superior cervical ganglion which lies beneath it. V. The vagus. P. A sympathetic filament, which is connected above with the superior cervical ganglion, and joins the vagus lower down. D. Branch of the first cervical nerve anastomosing with the superior cervical ganglion. R R. Glossopharyngeal nerve. I. Anterior branches of the superior cervical ganglion forming the inter-carotid plexus which accompanies the external carotid artery. P. A small sympathetic twig which ascends to the submaxillary gland, accompanying at first the inferior artery O, and another glandular artery P′. Q. Sympathetic filaments from the same source accompanying the facial artery and forming anastomoses with the mylo-hyoid branch of the fifth. U. The lingual nerve, from the posterior aspect of which the chorda tympani T arises and passes backwards to be distributed to the gland forming anastomoses with filaments of the sympathetic. S. External division of the spinal accessory nerve.

Plate CXIV.

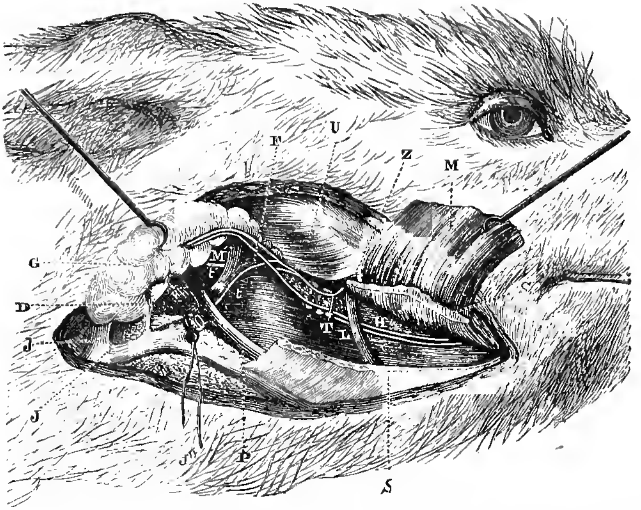


FIG. 310.—After Bernard. Anatomy of the parts exposed in operations on the submaxillary gland. The posterior half of the digastric muscle has been removed. M. Anterior half of the muscle drawn aside by a hook. M. Insertion of the posterior half, which has been removed in order to expose the carotid artery. *t t′*. Sympathetic filaments. G. Submaxillary gland drawn aside by a hook in order to show its deep surface. H. Submaxillary and sublingual ducts. J. Trunk of the external jugular vein. J′. Branch of the jugular vein passing behind the gland. J″. Branch of the jugular vein passing in front of the gland, cut across. D. A vein issuing from the submaxillary gland. *t t′*. Carotid artery accompanied by a sympathetic filament on either side; only one filament, *t*, is distinctly shown in the engraving. F. Origin of the inferior artery of the gland. P. Hypoglossal nerve. L. Lingual nerve. T. Chorda tympani going to the submaxillary gland. S S′. Mylo-hyoid muscle, cut across to show the lingual nerve and the salivary ducts which lie beneath it. U. Masseter muscle covering the angle of the lower jaw. Z. Origin of the mylo-hyoid nerve, which is hidden by the reflected digastric and mylo-hyoid muscles.

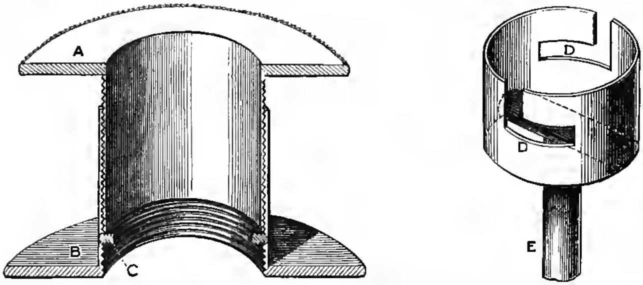


FIG. 311.—Gastric cannula seen in section, and key. A, outer flange; B, inner flange; C, projecting points by which the outer can be screwed round on the inner tube, so as to increase the distance between the flanges. D, D, is the key by which the tube is turned. It consists of a circle of metal, with two slits, D and D, into which the projections C pass. It is attached by a cross-bar to a handle E, which is about six or eight inches long, though cut short in the engraving.

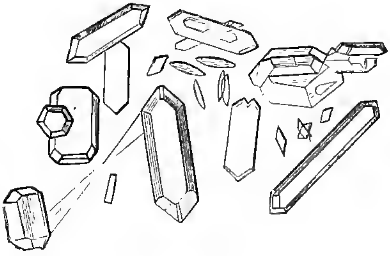


FIG. 312.—Taurine.

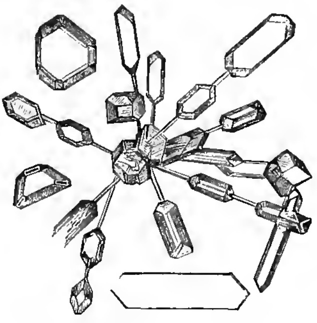
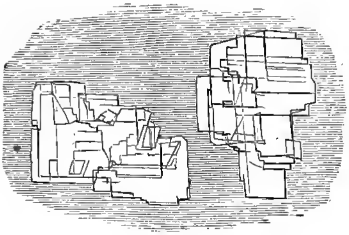


FIG. 313.—Hippuric acid.

PLATE CXV.



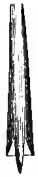


FIG. 314.—Cholesterin.

FIG. 315.—Point of the instrument used for puncturing the fourth ventricle to produce diabetes,

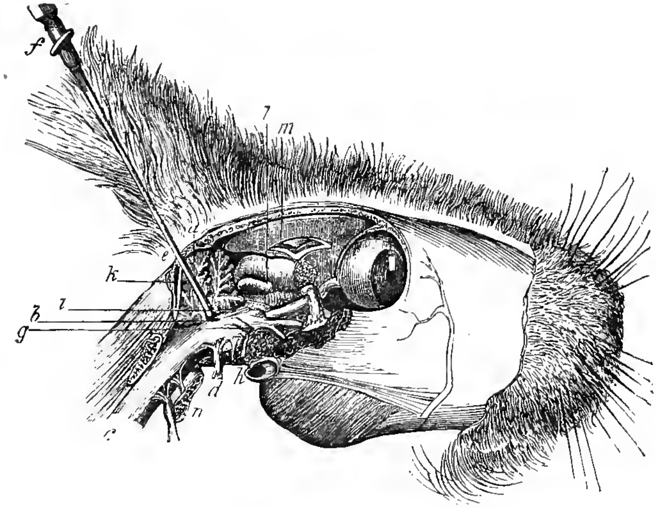


FIG. 316.—After Bernard. Section of a rabbit's head, showing the direction taken by the instrument in puncturing the fourth ventricle. *a*, cerebellum; *b*, origin of the seventh nerve; c, spinal cord; *d*, origin of the vagus; *e*, point where the instrument enters the cranium; *f*, the instrument; *g*, the fifth nerve; *h*, auditory canal; *i*, extremity of the instrument reaching the medulla, after having passed through the cerebellum; *k*, occipital venous sinus; *l*, corpora quadrigemina; *m*, the brain; *n*, section of the atlas.

PLATE CXVI.

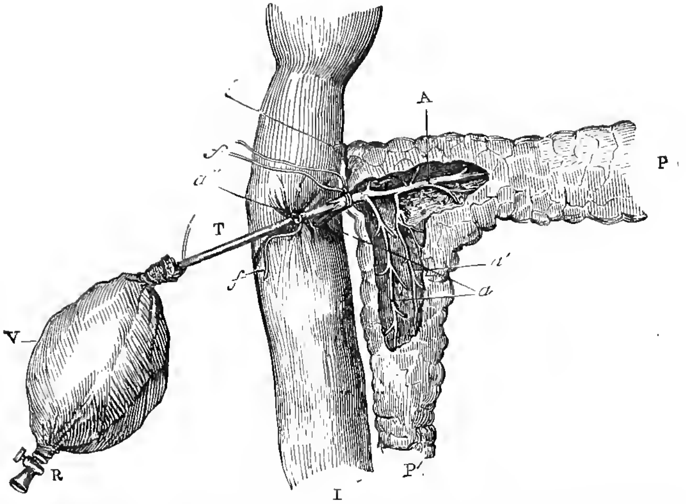
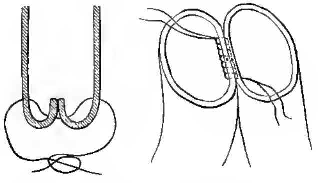


FIG. 317.—Arrangement of the cannula in a temporary pancreatic fistula. A, the chief pancreatic duct of the dog directed transversely; *a*, insertion of the pancreatic ducts into the intestine; the insertion of the smaller duct is higher up, and is marked by a line without a letter; *a′*, a branch of the larger duct within the gland; *a″*, ligature, fastening the cannula T to the intestine; *f f*, is a thread by which the cannula is fastened into the pancreatic duct; I, is the intestine; P P′, the pancreas; T, the silver cannula; R, the stopcock, for letting out the pancreatic juice which has accumulated in the india-rubber bag; V, an india-rubber bag, tied to the outer end of the cannula, and used for collecting the juice.



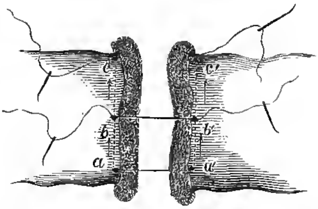


FIG. 318.—The left-hand diagram shows the method of stitching up the end of the divided intestine so as to form a *cul-de-sac* in Thiry's fistula. The right hand figure shows the method of stitching together the divided intestine. The two black dots in the middle of the pieces already joined, indicate the position of the mesenteric vessels. The first stitch should surround these vessels and serve as a ligature for them. Five or six similar stitches at each side of the first serve to join the one edge, as shown here. The two ends of intestine are then pulled into the same straight line and the junction finished, as shown in fig. 319.

FIG. 319.—Shows the method of applying the final stitches to join the divided intestine in Thiry's fistula. The two ends of intestine are represented as entirely apart, but the other half of the circumference must be understood to be already sewn together in the manner shown in fig. 318.

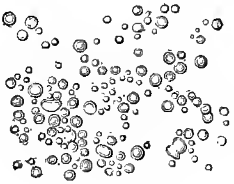


FIG. 320.—Milk.

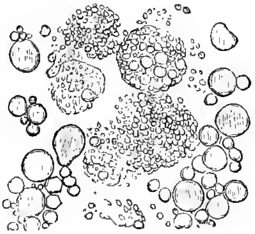


FIG. 321.—Colostrum.

PLATE CXVII.

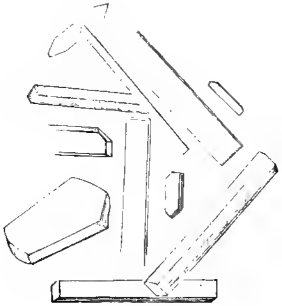


FIG. 322.—Urea.

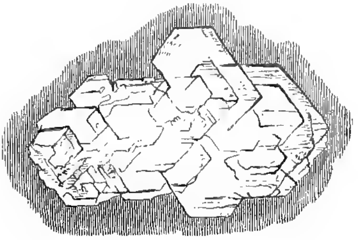


FIG. 323.—Nitrate of urea.

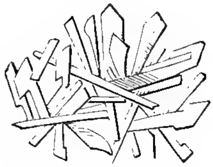


FIG. 324.—Oxalate of urea.

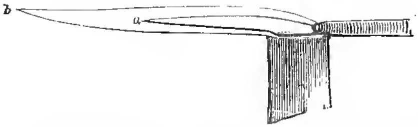


FIG. 325.—Blowpip flame. *a*, reducing, *b*, oxidizing part of the flame.

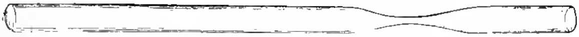


FIG. 326.—Piece of glass drawn out to form a pipette.

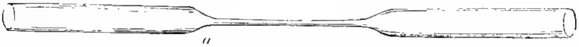
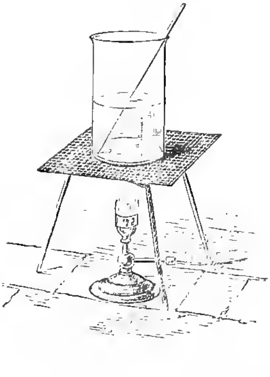


FIG. 327.—A tube drawn out in order to seal it. The operation is completed by directing the point of a blowpipe flame on the point *a*, and drawing the two ends of the tube rapidly apart.



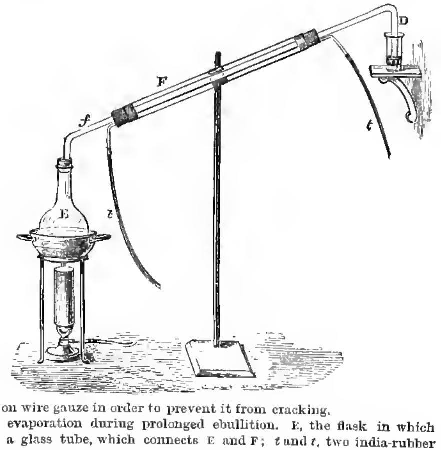


FIG. 328.—Solution. The beaker is supported on wire gauze in order to prevent it from cracking.

FIG. 329.—Apparatus for preventing loss by evaporation during prolonged ebullition. E, the flask in which the liquid is boiled; F, a Liebig's condenser; *f*, a glass tube, which connects E and F; *t* and *t*, two india-rubber tubes, which convey a stream of water to and from the condenser. The vapour from E is condensed in F, and runs back into E. Any of the condensed liquid that passes beyond the bend of the glass tube D, which is connected to the upper end of F, is collected in the small vessel below, D, passes to the bottom of the vessel, and as soon as any quantity of liquid accumulates in it, the flame may be removed from under E; a vacuum then forms in E, and the liquid rushes back into it.

PLATE CXVIII.

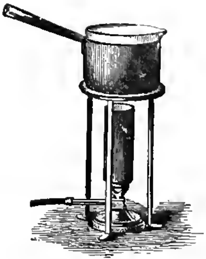


FIG. 330.—Saucepan used as a water-bath.

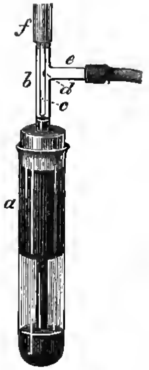


FIG. 331.—Bunsen's gas regulator as modified by Geissler. *a*, is a wide glass tube divided into two parts, an upper and lower, by a horizontal septum, from which a tube runs down nearly to the bottom of the lower one. The upper division and part of the lower one is filled with mercury. *b*, is a glass tube passing through the cork of *a*, and connected at *f* and *e* with the gas pipe and the burner. c, is an inner glass tube whose edges are luted to those of *b* at *f*. *d*, is a small hole in *c*, allowing sufficient gas to pass through it to prevent the flame from being extinguished. The gas enters at *f* and passes through the inner tube *c* to the burner by *e*, or *vice versâ*. The instrument is set by warming it to the desired temperature, and then pushing down *b* till the end of c touches the mercury. The gas is then prevented from passing through c, and only enough passes through the hole *d* to keep the flame alive, till, the instrument becoming cooler, the mercury contracts, and allows the gas again to pass through the lower end of c.

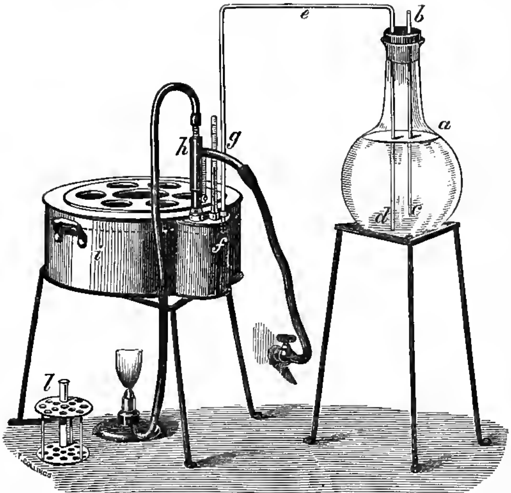


FIG. 332.—Water-bath for experiments on digestion, or for evaporating at a constant temperature. This consists of two parts, the bath itself, *i*, and an apparatus, *a*, for keeping the water in the bath at a constant level. *a*, is a large flask containing water. *b*, c, is a straight glass tube open at both ends. *d*, *e*, *f*, is a bent tube with limbs of equal length. The end, *c*, is put at the level at which the water in the bath, *i*, is to remain. Both ends, *d* and *f*, are about an inch below *c*, and thus form a syphon, the effective difference between whose limbs is the vertical distance between c and *d*, or about an inch. Whenever the water in *i* falls below the level of *c*, the syphon acts, and water runs through it until the level in *i* is as high as c, when it ceases. *g*, is opposite a thermometer for ascertaining the temperature of the bath. *h*, is a gas regulator. The one represented here differs somewhat from that in fig. 331, but is more expensive and has no advantage over the other. *i*, is the water-bath of galvanized zinc or tin. The dotted line represents the level of the water. It is covered by a large plate perforated with holes, in which beakers containing digestive fluids or evaporating basins can be put. The centre one is the largest, and contains the test-tube rack. When not in use the holes are covered by plates of zinc. The perforated plate itself can be removed, and a large dialyzer, fig. 337, put in its place, when digestion and dialysis are to be carried on at the same time. *l*, is a tin rack for holding test-tubes in which digestive fluids are placed. The holes in the upper plate of the rack are numbered, so that the tubes may be recognised without the necessity of attaching a label to them. Those in the lower plate are much smaller than in the upper, and serve only to prevent the tubes from slipping aside.

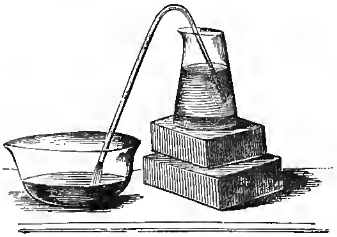
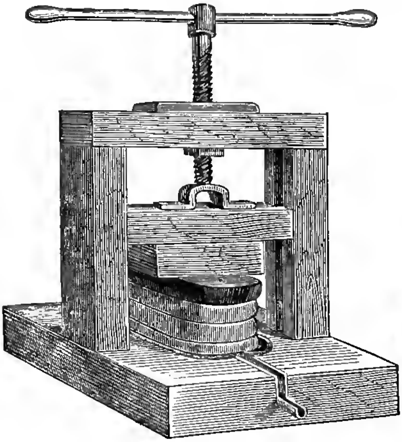


FIG. 333.—Use of the syphon in washing precipitates by decantation.

PLATE CXIX.



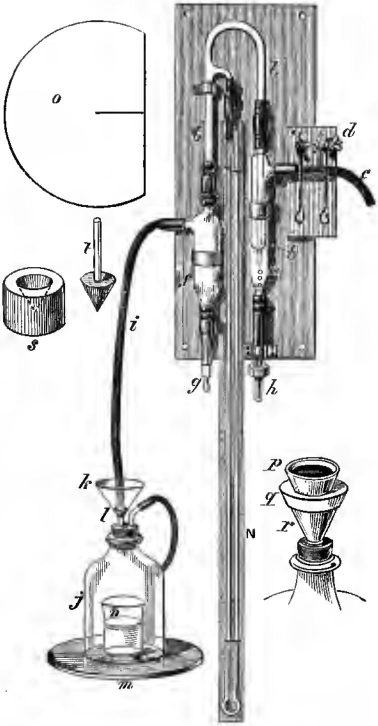
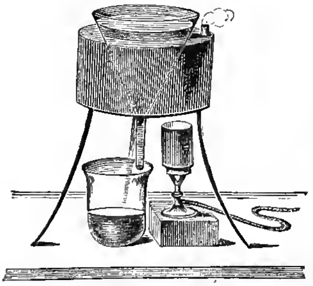


FIG. 334.—Screw-press. The substance from which the fluid is to be expressed is wrapped in strong flannel or calico, and the liquid which oozes out is collected as it runs from the small spout.

FIG. 335.—Bunsen's water air-pump. This consists of a wide glass-tube *a*, into which another tube *b*, *b′*, *b″*, passes air-tight. *c*, is an india-rubber tube connecting *a* with the water supply. *d*, is a clamp to stop the flow of water through *c*. *e*, is another clamp to regulate the flow. *f*, is a reservoir to prevent any water which may accidentally come over from getting into *j*. *g*, is a plug to let out any water from *f*. *h*, is a screw for connecting *a* air-tight to a piece of tubing, which should pass 32 feet, if possible, below the level of *a*. *i*, is a piece of strong india-rubber tubing to connect the air-pump with *j*, the bell-jar, to be exhausted. The water rushes in at c and down *h*, carrying bubbles of air with it, as shown opposite *a*, till the exhaustion is complete. *a* is represented as half full of water. *k*, a funnel fixed air-tight in the india-rubber stopper of *j*. *l*, a small cone of platinum foil to prevent the filter from being broken. *m*, a plate of ground glass. *n*, a beaker to receive the filtrate. N, a manometer to measure the degree of exhaustion. *o*, a piece of platinum foil of the proper size and shape to make the cone, *l*. *s*, a mould, and *t*, a stamp, to give the proper shape to the cone, *l*. *p*, is a cone of porous earthenware used as a funnel. *q*, is a piece of wide india-rubber tubing stretched over the funnel *r*, and holding the cone *p* air-tight. *r*, is a funnel inserted into the stopper of a bell-jar. The bell-jar may either be exhausted by means of a tube in the stopper, like *j*, or by a tubulature in the side, as is supposed to be the case with that holding *r*.



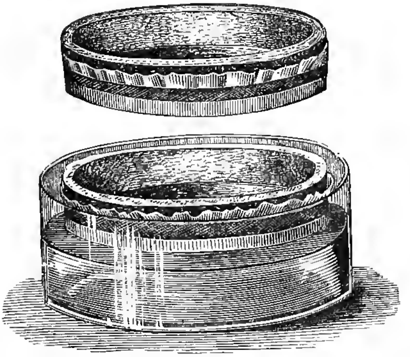


FIG. 336.—Plantamour's funnel for keeping fluids hot during filtration. It may also be used to keep liquids at the freezing point during filtration, by substituting ice for hot water. There are two kinds of these funnels. One of them has simply a wide opening above, and a narrow one below, which is closed by a cork through which the tube of a glass funnel passes. The glass funnel which contains the filter is thus in direct contact with the warm water or ice with which the metal funnel is filled. The other form has a copper funnel in the situation of the dotted line and in this the glass funnel is placed. The glass funnel is therefore only indirectly surrounded by the water or ice on the apparatus, and its temperature can therefore not be so exactly regulated, but it can be removed with great facility and another put in its place, which is not the case when the other form is employed.

FIG. 337.—Dialyzer of gutta-percha. The upper figure shows the dialyzer with the parchment paper stretched over it. The lower shows it in use floating on water.

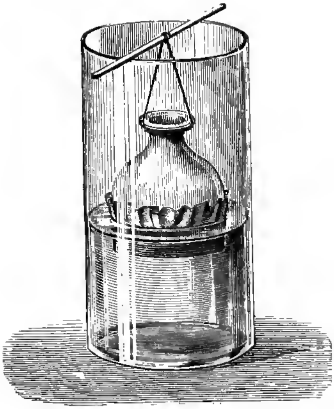


Fig. 338.—Dialyzer suspended in water.

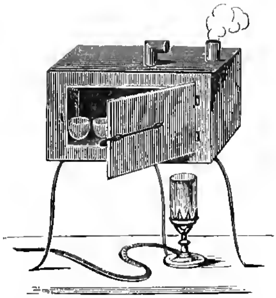


Fig. 339.—Hot air bath for drying precipitates, &c.

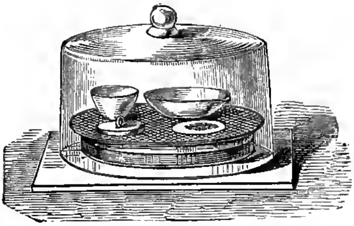


Fig. 340.—Bell-jar and dish, containing sulphuric acid for drying and cooling substances.

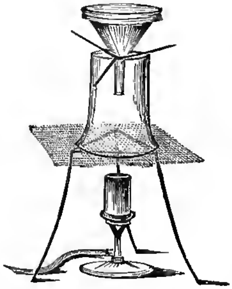


Fig. 341.—Method of drying precipitates.

Fig. 342.—Platinum triangle stretched upon a larger iron one for ignition.

Fig. 343.—Specific gravity bottle.

Fig. 344.—Specific gravity bottle.

Fig. 345.—Bottle for taking the specific gravity of small quantities of liquids.

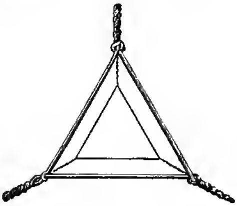


Fig. 342.

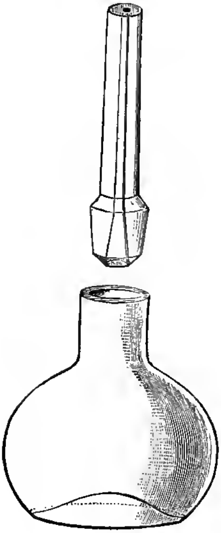


Fig. 343.

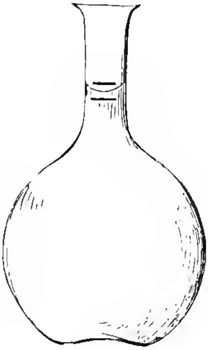


Fig. 344.

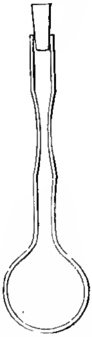


Fig. 345.

PLATE CXXI.

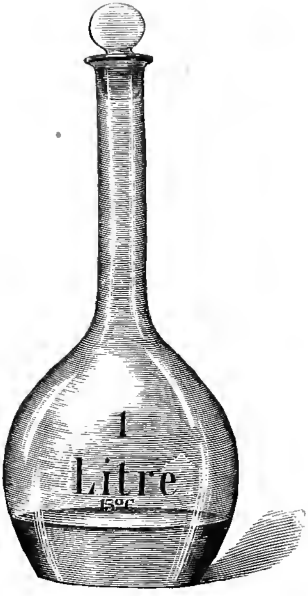


FIG. 346.

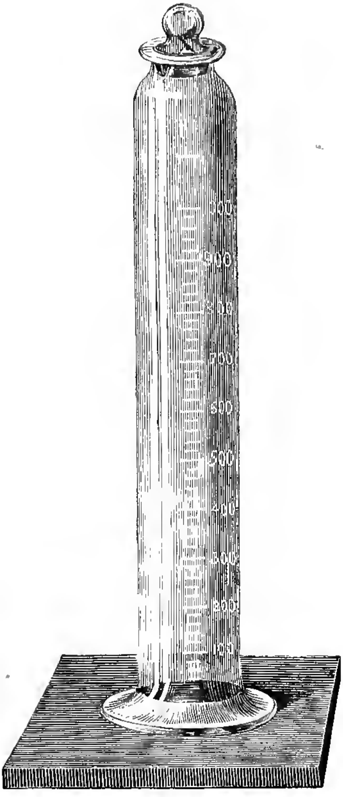


FIG. 347.

FIG. 346.—Measuring flask. (From Sutton's Handbook of Volumetric Analysis.)

FIG. 347.—Test mixer. (From Sutton's Handbook of Volumetric Analysis.)

PLATE CXXII.

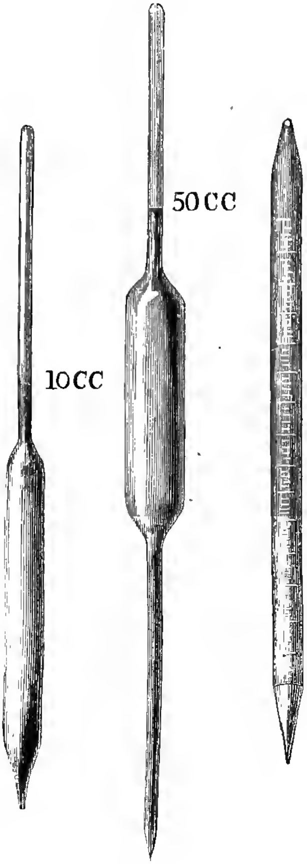


FIG. 348.

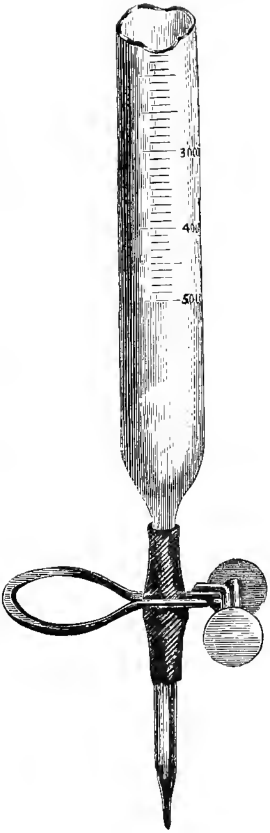


FIG. 349.

FIG. 348.—Pipettes. (From Sutton's Handbook of Volumetric Analysis.)

FIG. 349.—Mohr's burette. (From Sutton's Handbook of Volumetric Analysis.)

PLATE CXXIII.

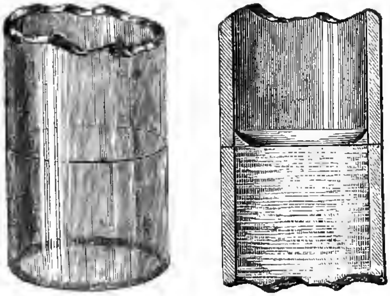


FIG. 350.

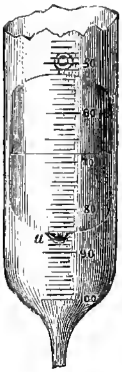


FIG. 351.

FIG. 350.—From Sutton's Handbook of Volumetric Analysis. The figure to the left shows the elliptical appearance presented by a line round a burette or by the surface of fluid in it, when the eye of the observer is above it. The figure to the right shows the curved surface of fluid in a tube. In reading off its level, the lower border of the dark zone must coincide with the graduation of the burette as in the figure, where the dark line stretching across the tube indicates one of the graduated lines upon it.

FIG. 351.—Erdmann's float. (From Sutton's Handbook of Volumetric Analysis.)

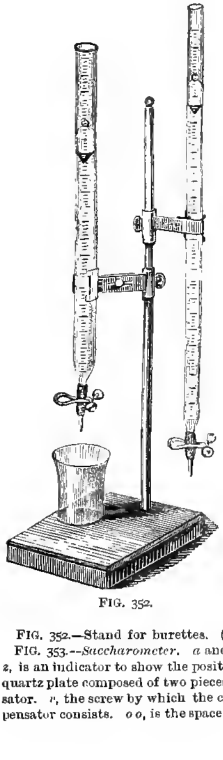


FIG. 352.

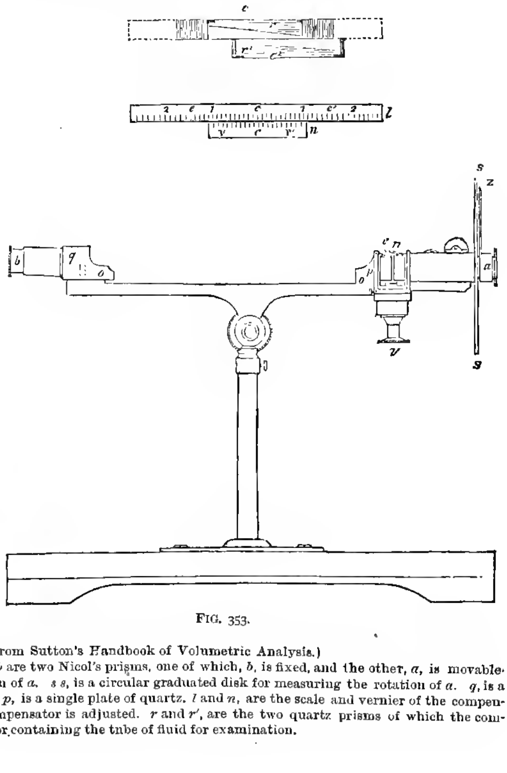


FIG. 353.

FIG. 352.—Stand for burettes. (From Sutton's Handbook of Volumetric Analysis.)

FIG. 353.—*Saccharometer*. *a* and *b* are two Nicol's prisms, one of which, *b*, is fixed, and the other, *a*, is movable. *z*, is an indicator to show the position of *a*. *s s*, is a circular graduated disk for measuring the rotation of *a*. *q*, is a quartz plate composed of two pieces. *p*, is a single plate of quartz. *l* and *n*, are the scale and vernier of the compensator. *v*, the screw by which the compensator is adjusted. *r* and *r'*, are the two quartz prisms of which the compensator consists. *o o*, is the space for containing the tube of fluid for examination.